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(54) **POWER TRANSFER SYSTEM WITH PATIENT TRANSPORT APPARATUS AND POWER TRANSFER DEVICE TO TRANSFER POWER TO THE PATIENT TRANSPORT APPARATUS**

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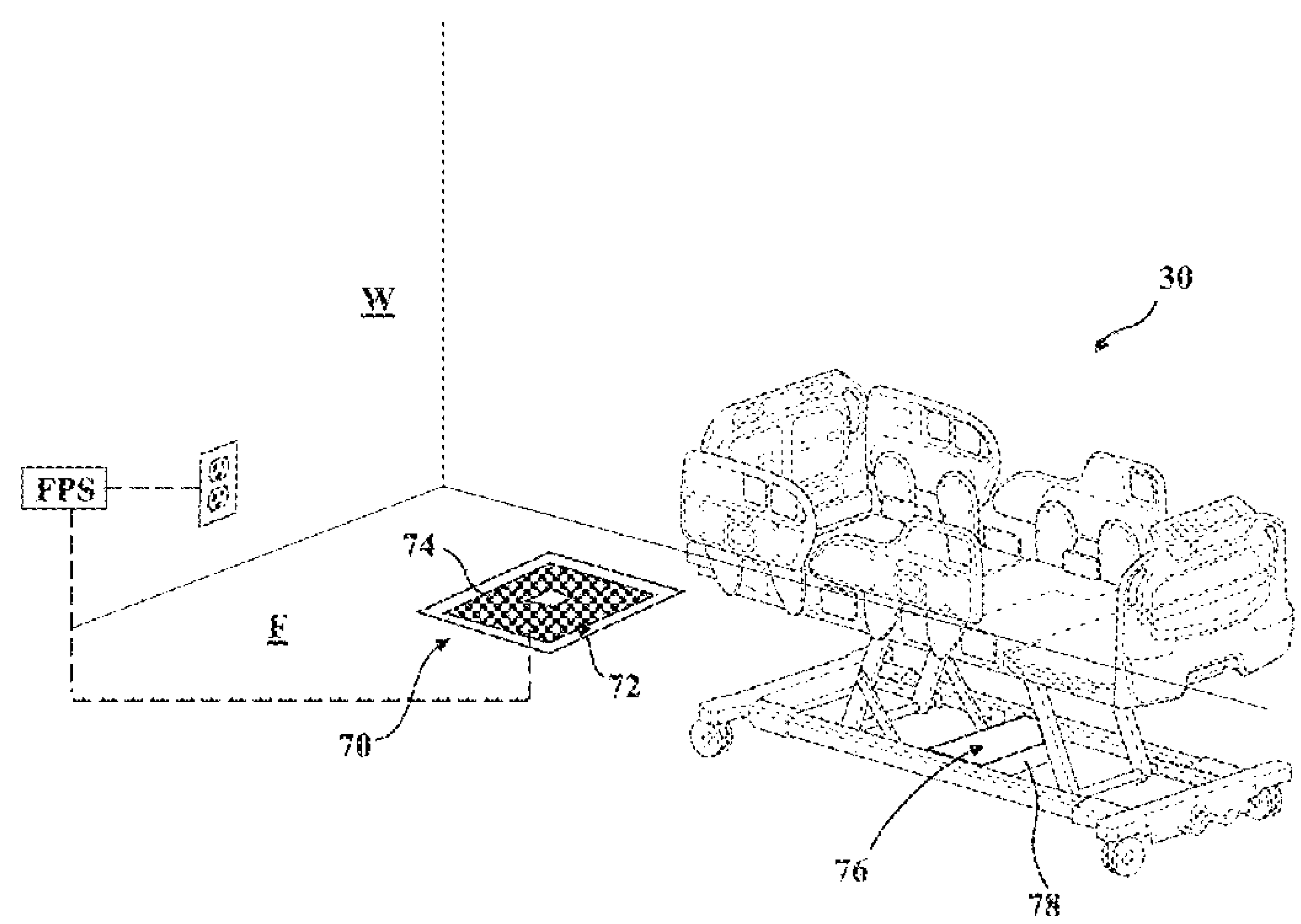
(57) **ABSTRACT**

A power transfer system comprises a patient transport apparatus and a power transfer device. The power transfer system provides convenience and ease of connection between a power source and the patient transport apparatus to provide power to one or more electrically powered devices on the patient transport apparatus or to provide energy for an energy storage device on the patient transport apparatus.

17 Claims, 34 Drawing Sheets



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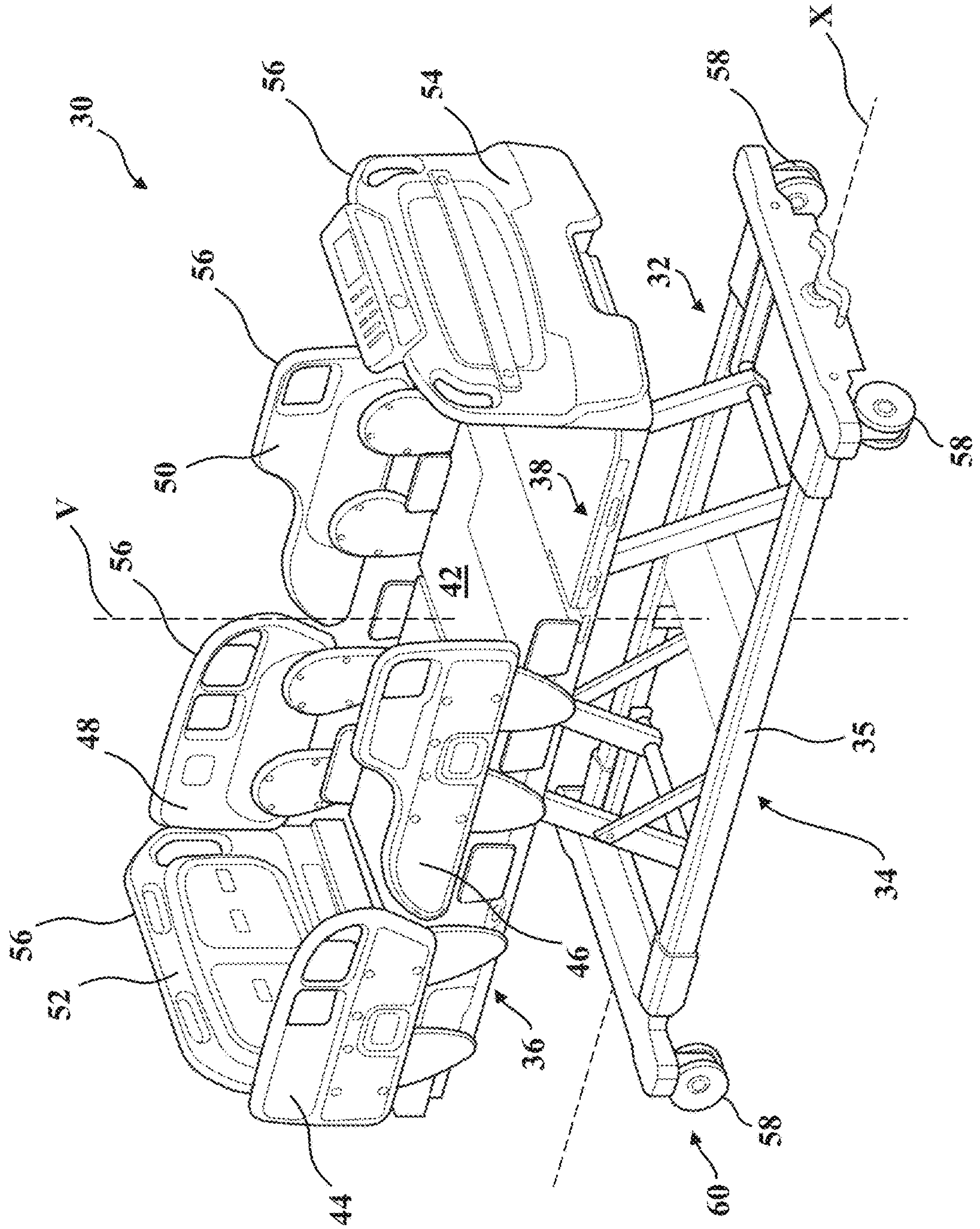


FIG. 1

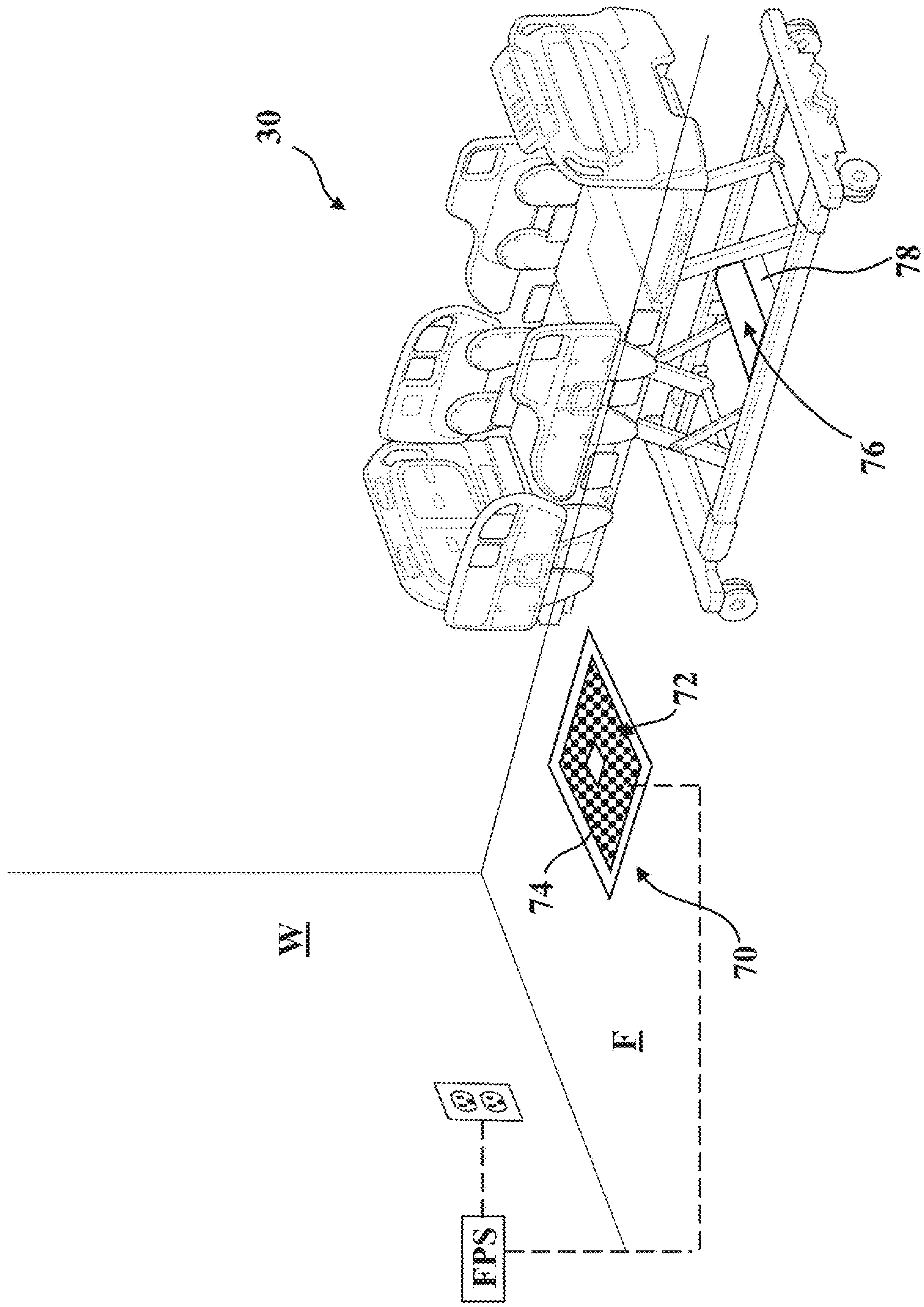
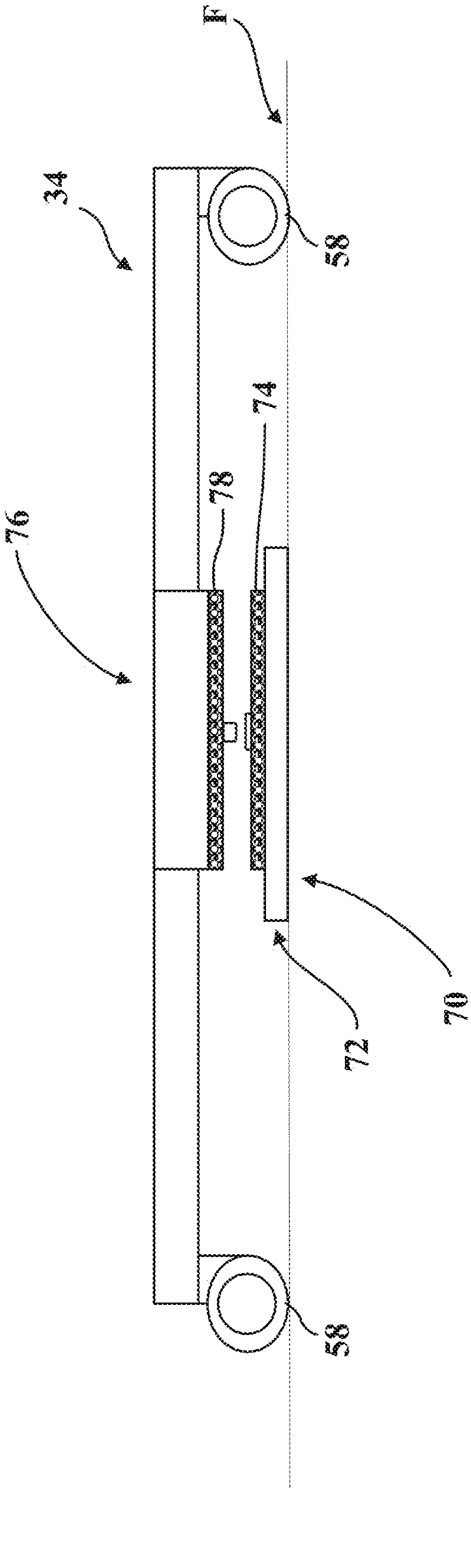


FIG. 2



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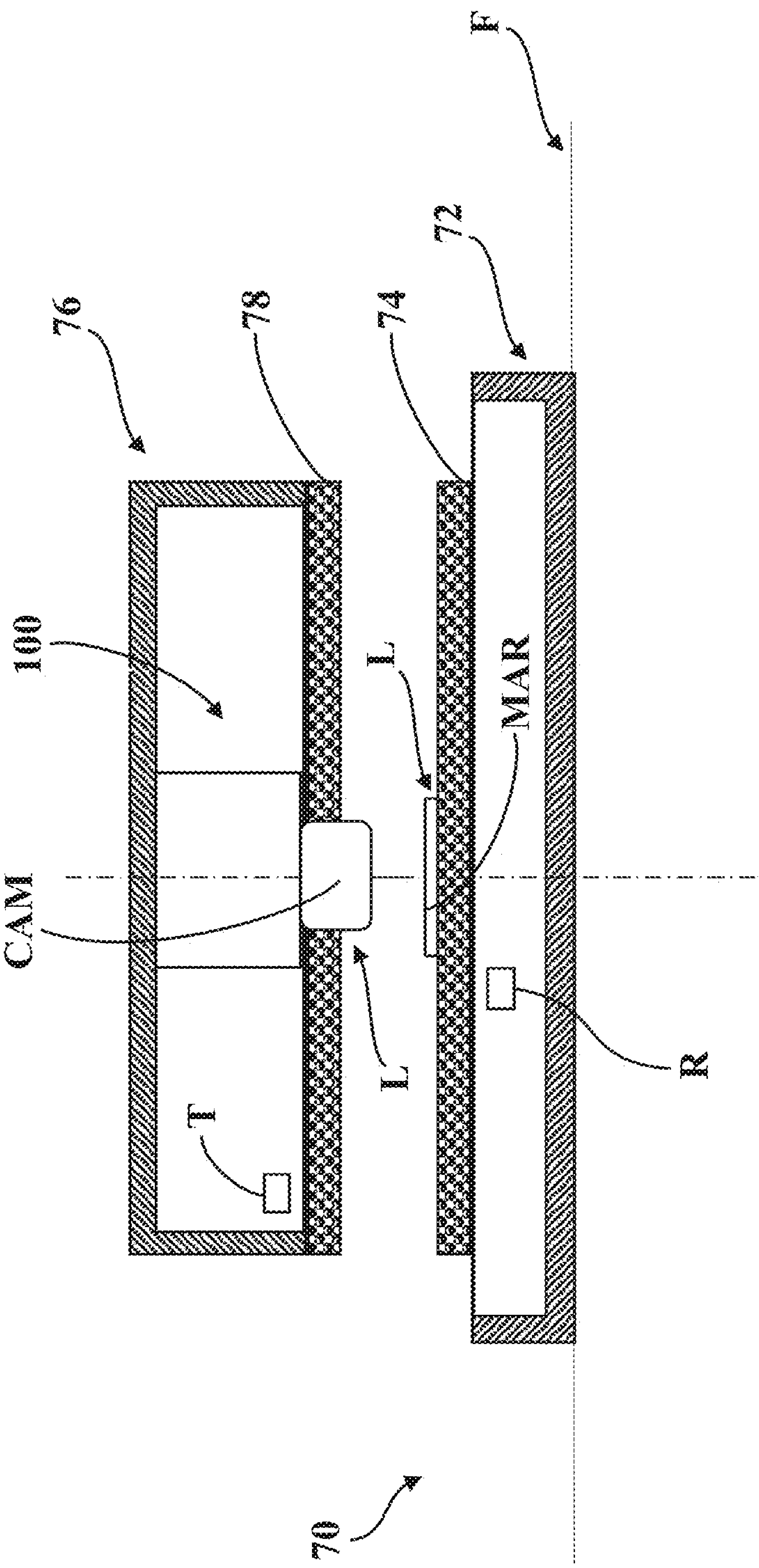

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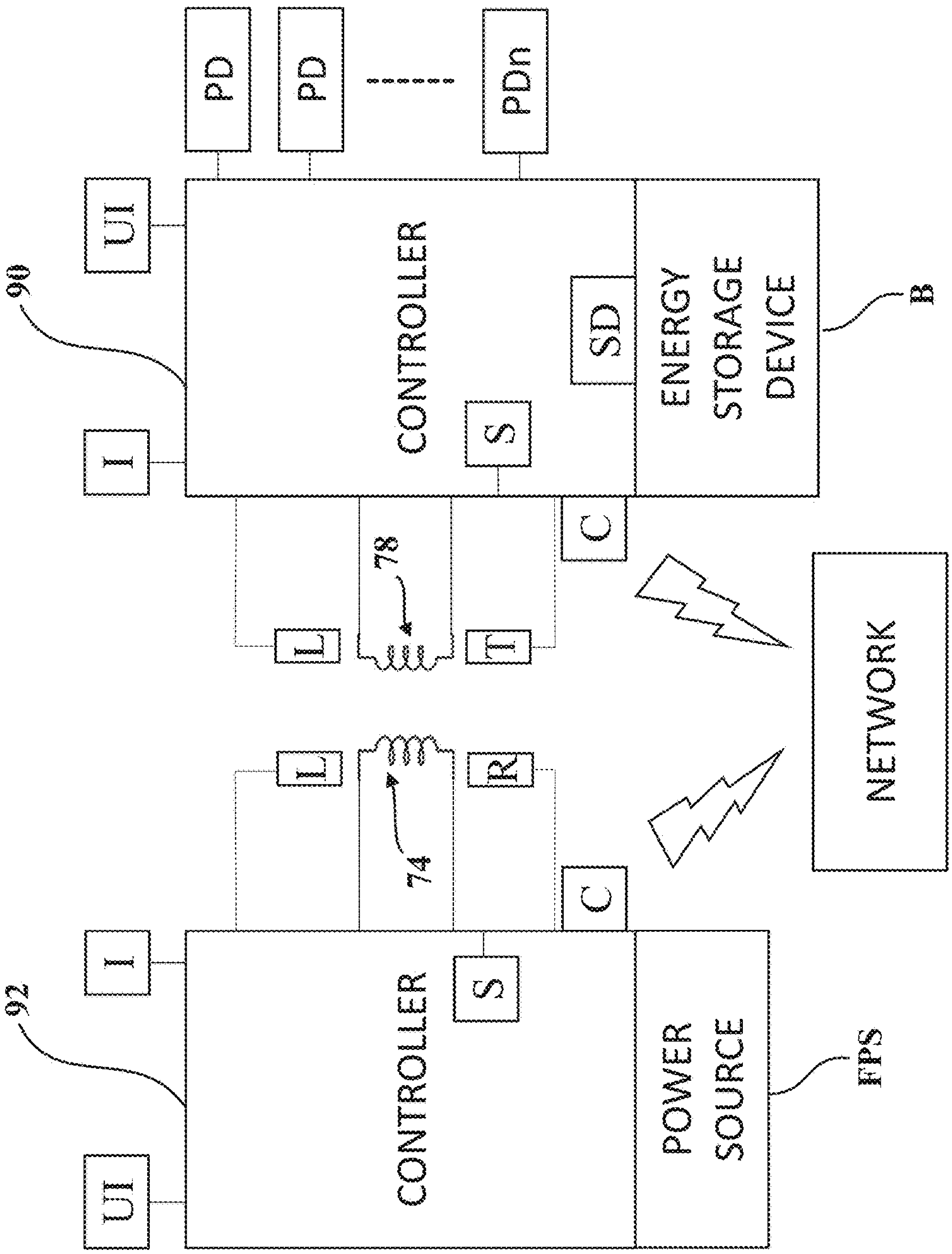
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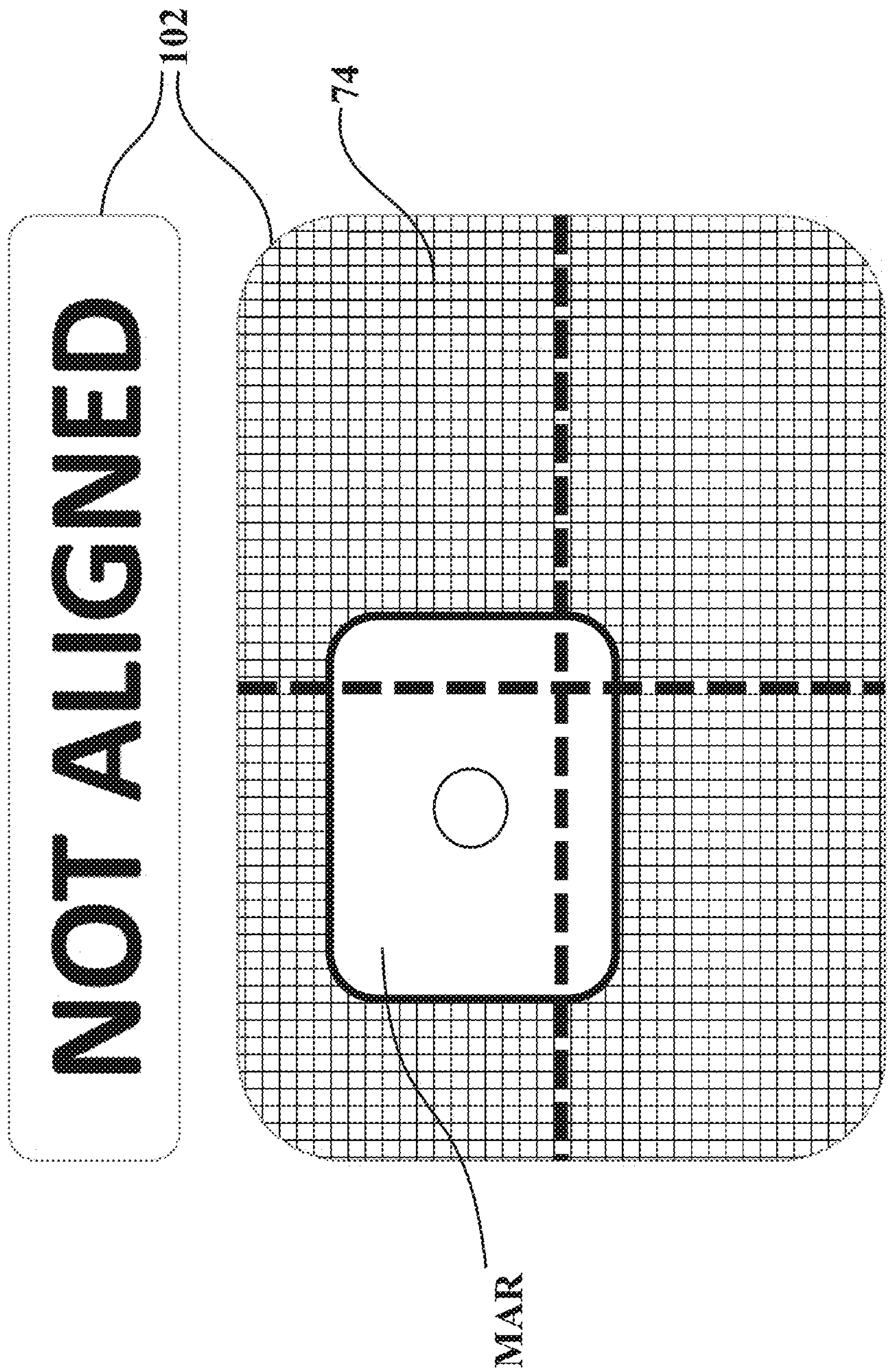
FIG. 5



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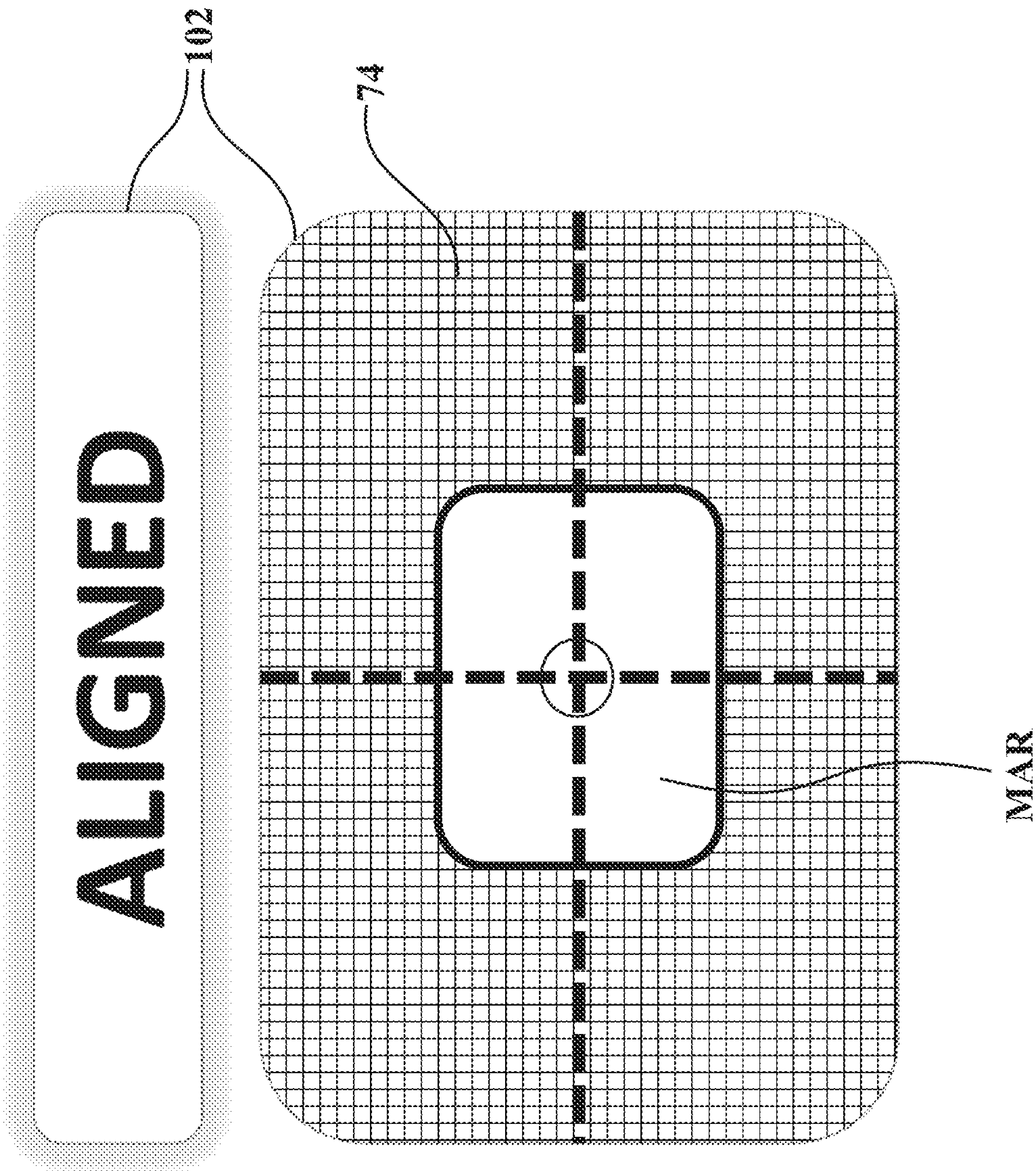


FIG. 7

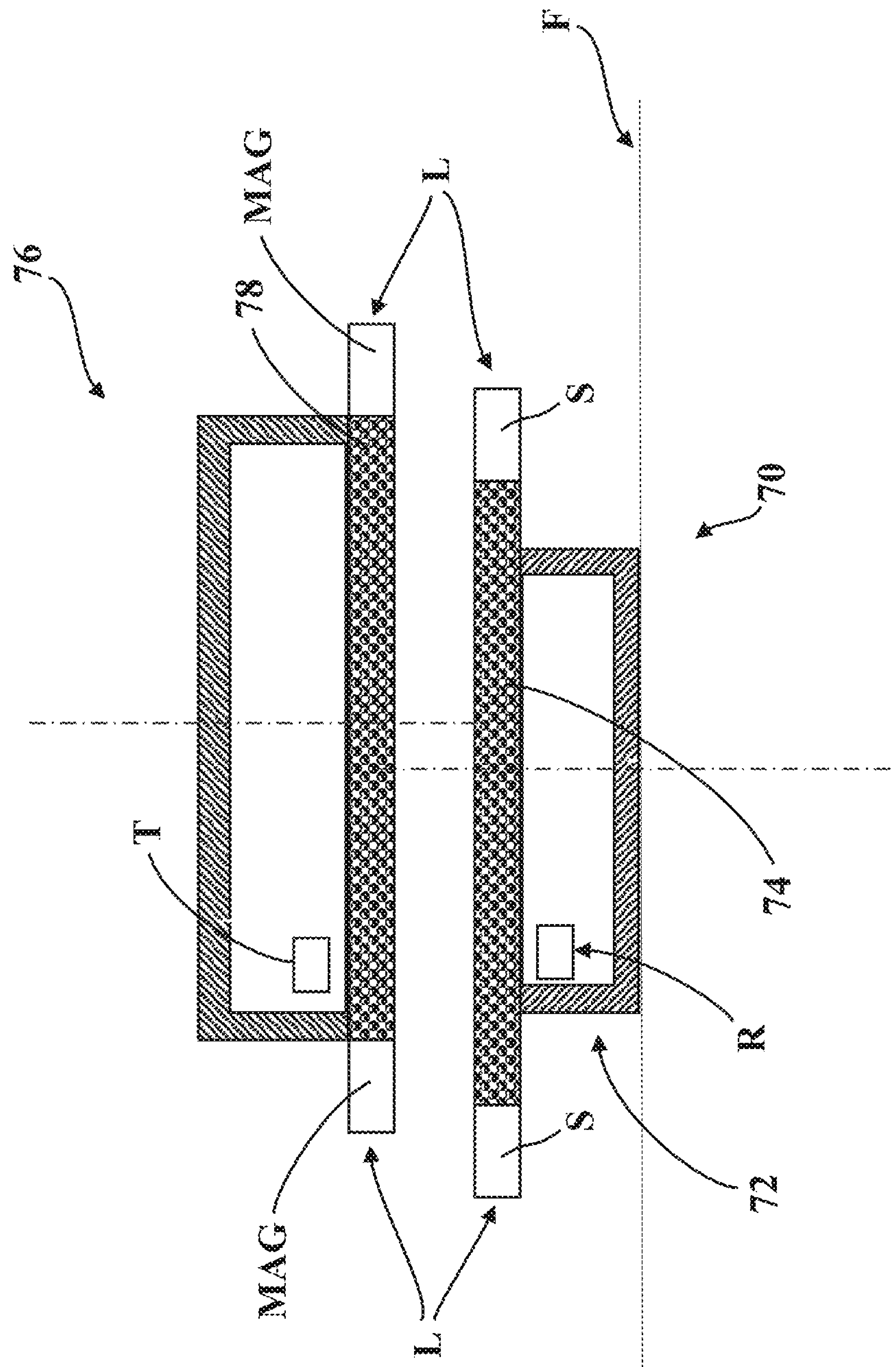


FIG. 8

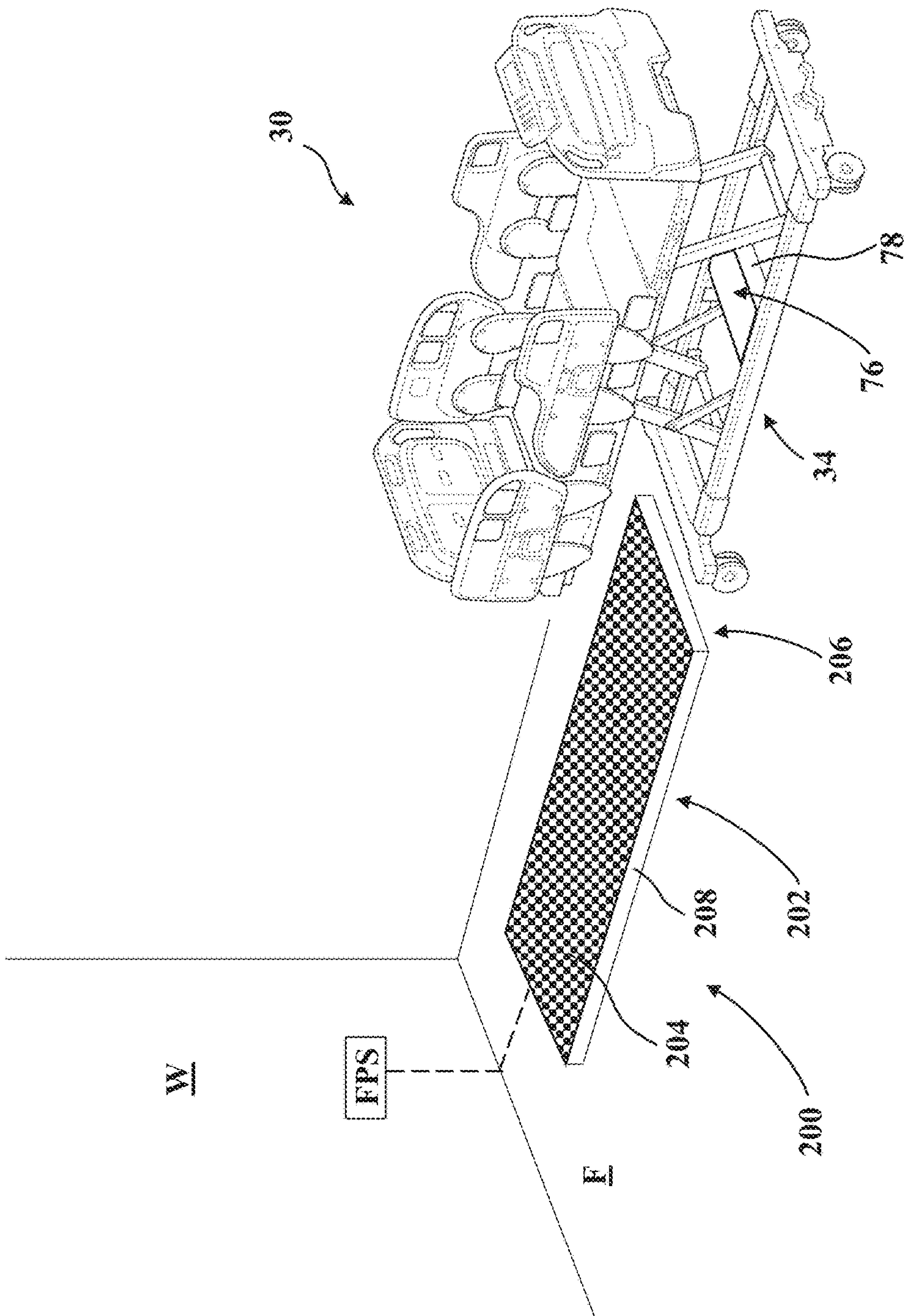


FIG. 9A

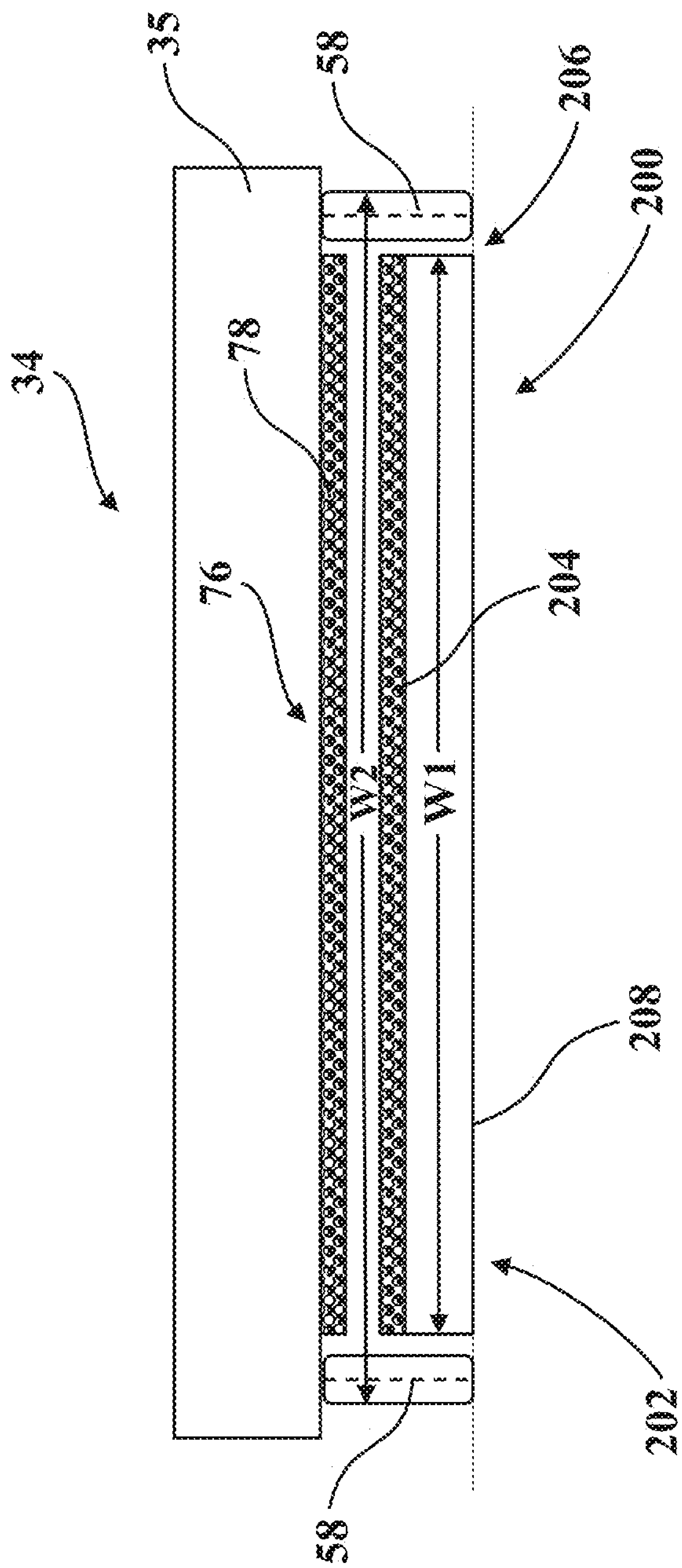


FIG. 9B

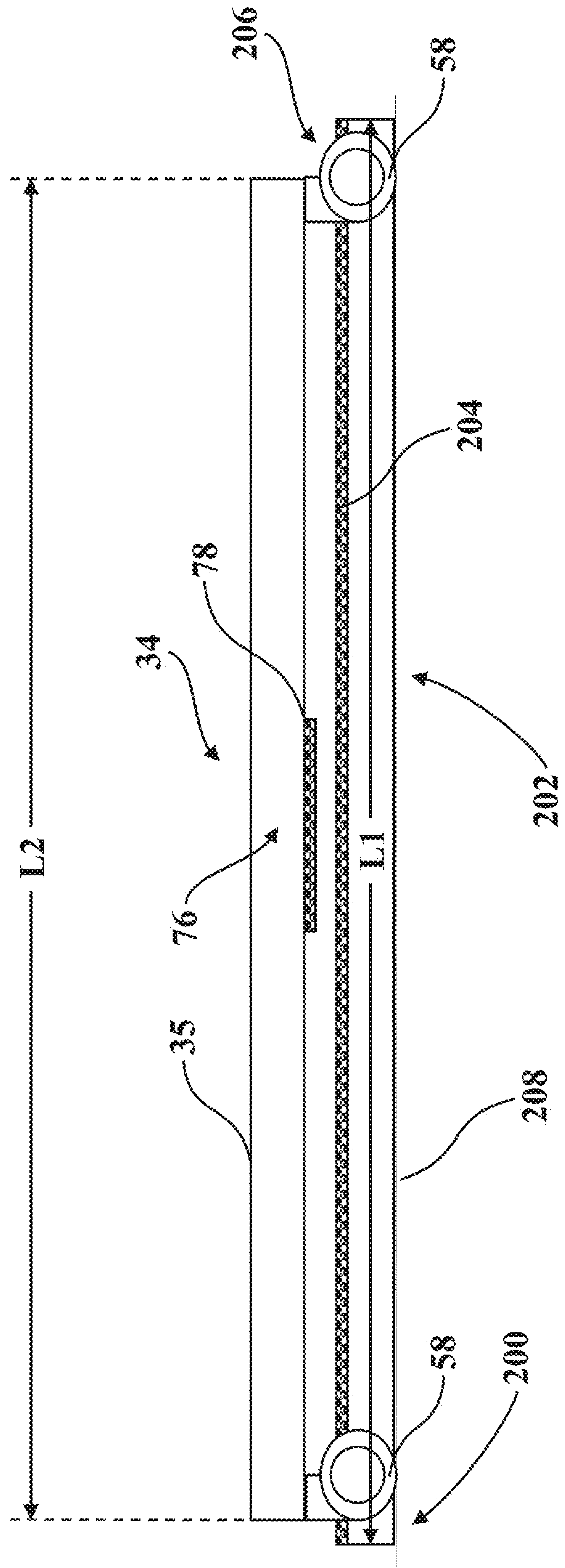


FIG. 9C

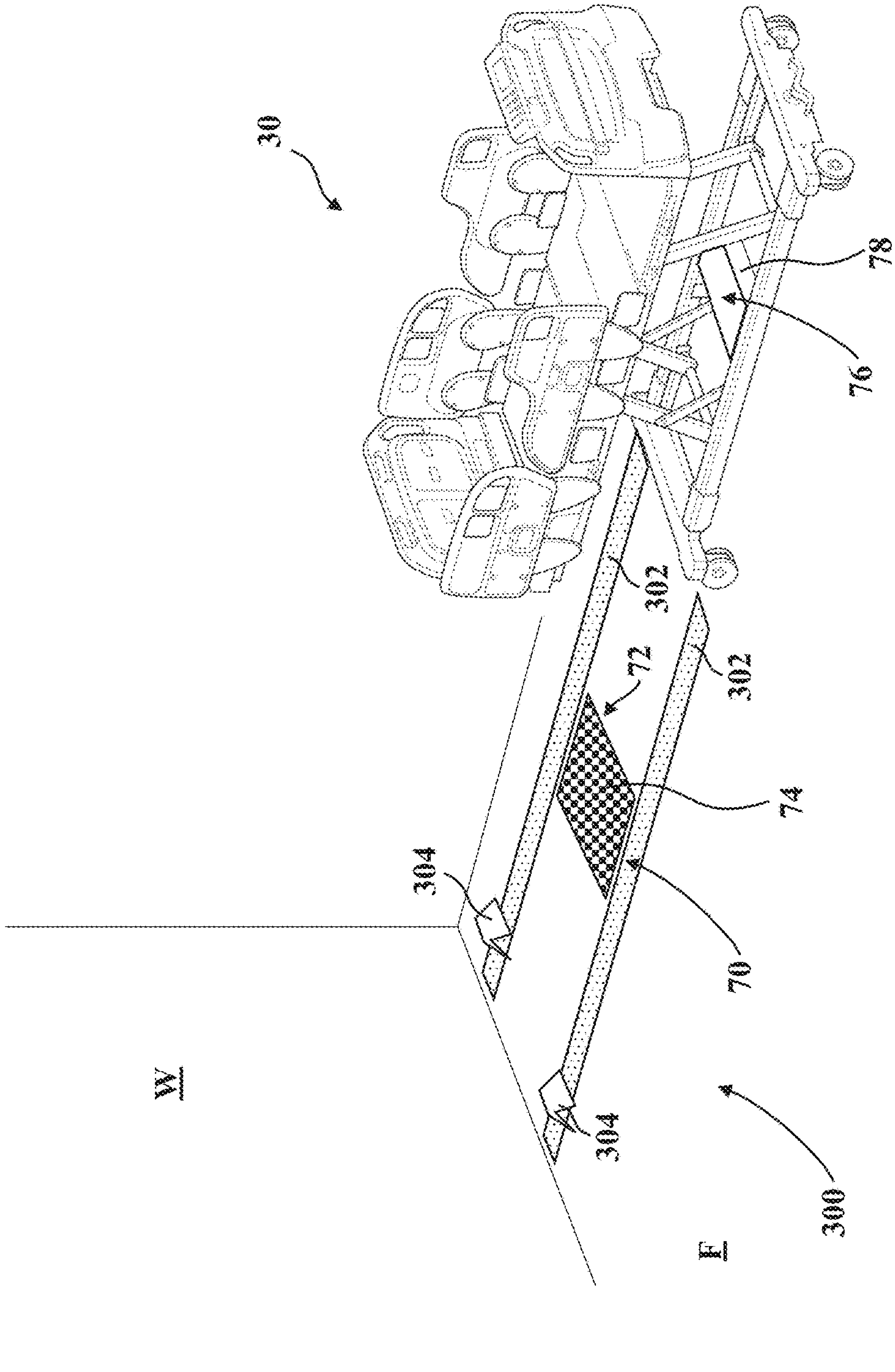
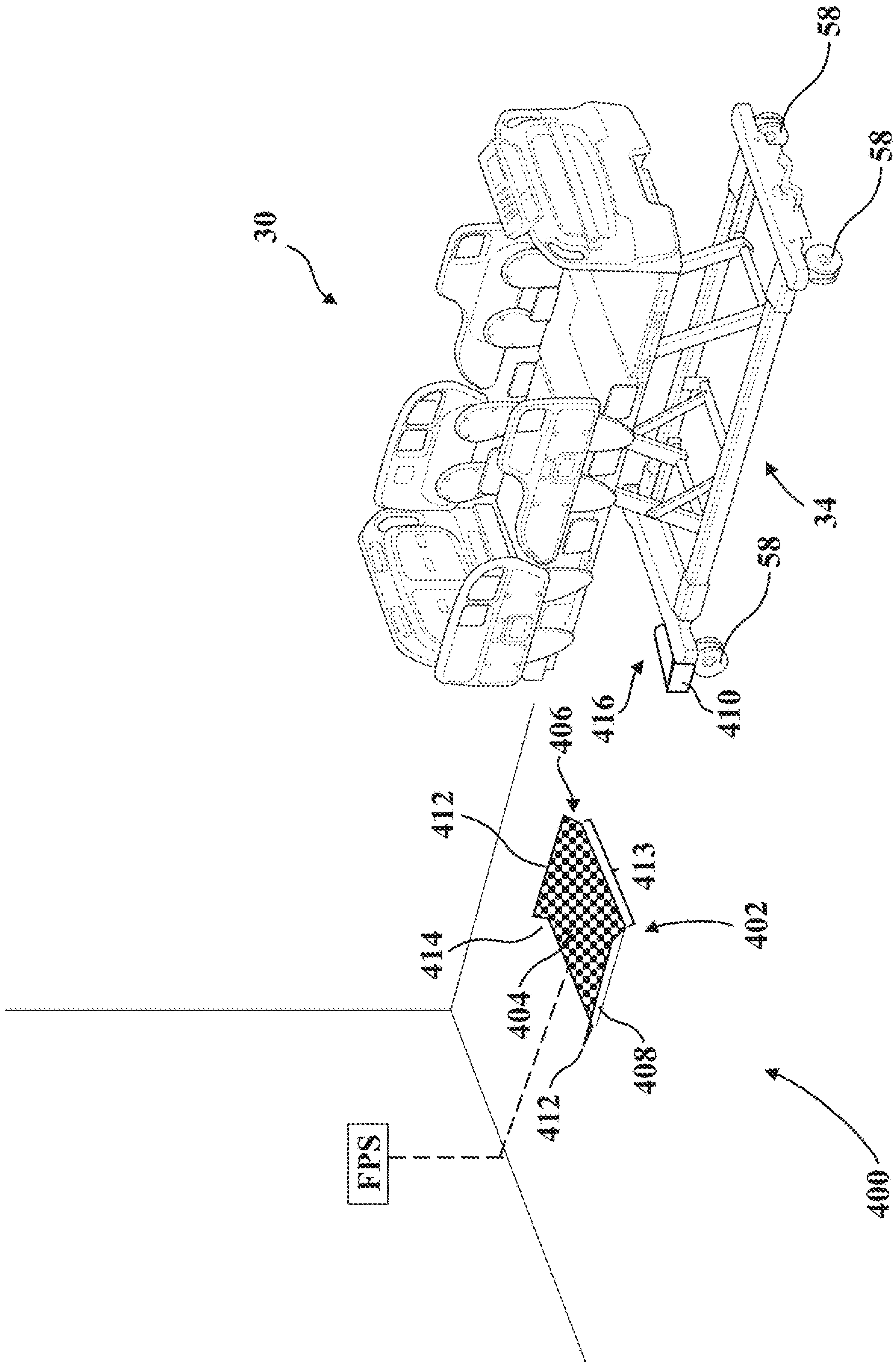


FIG. 10



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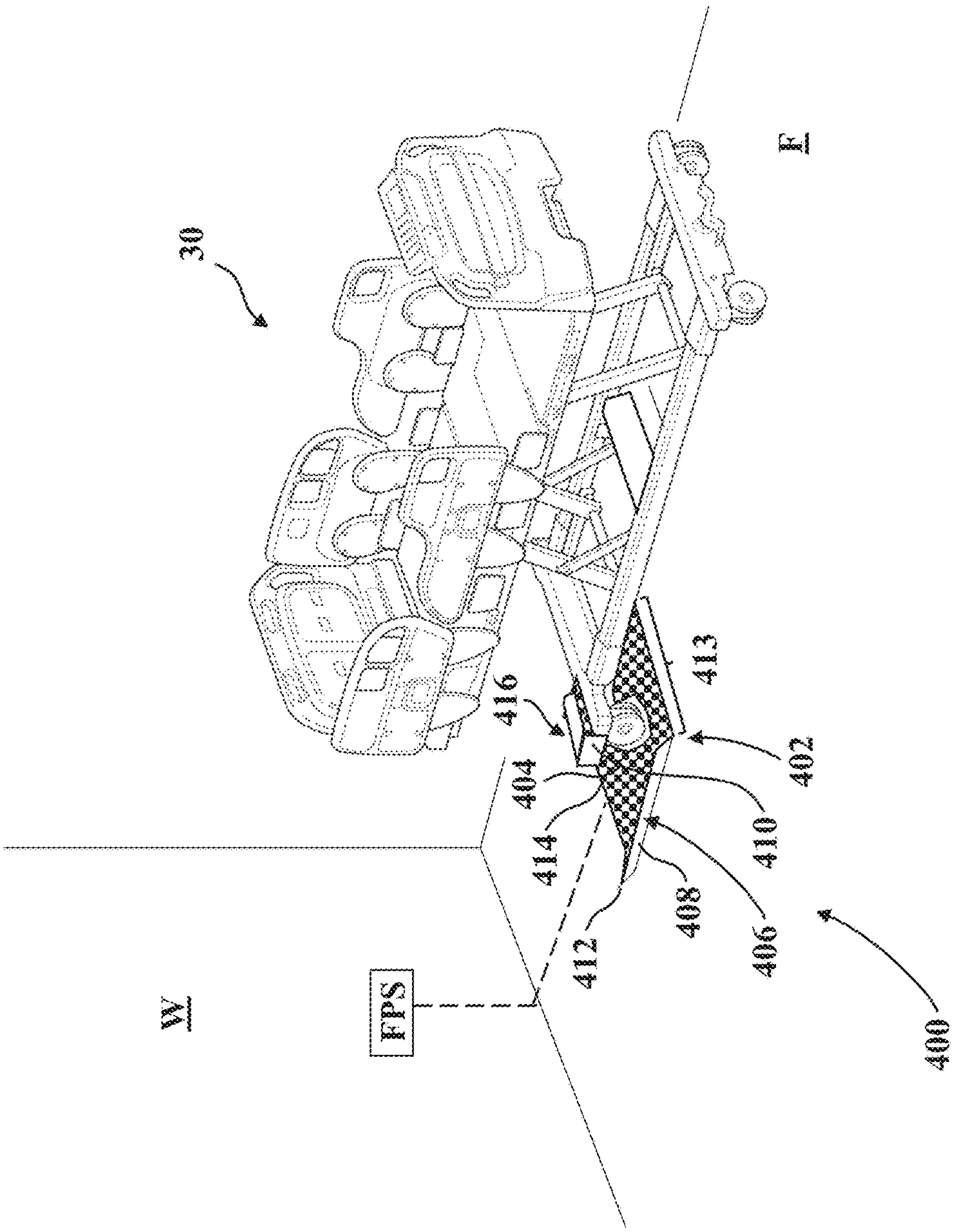

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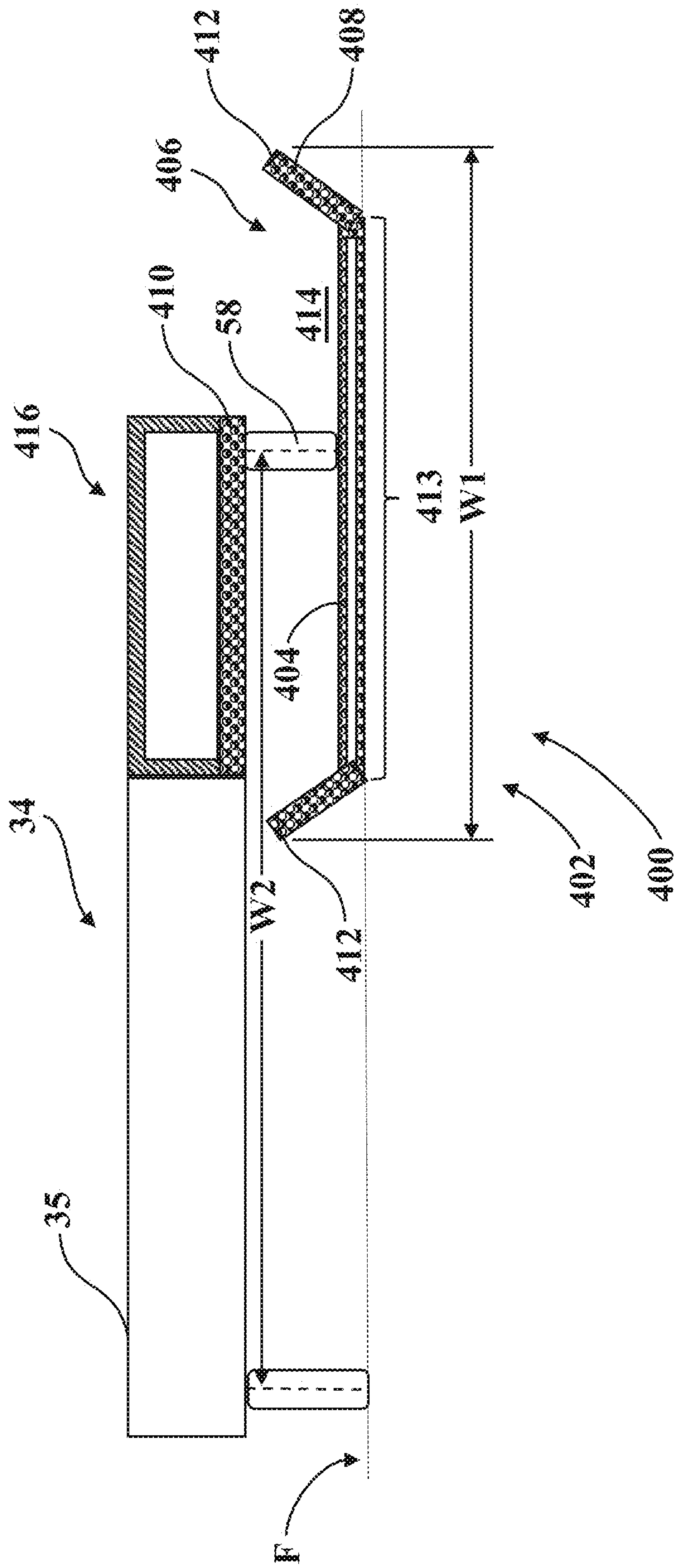


FIG. 13

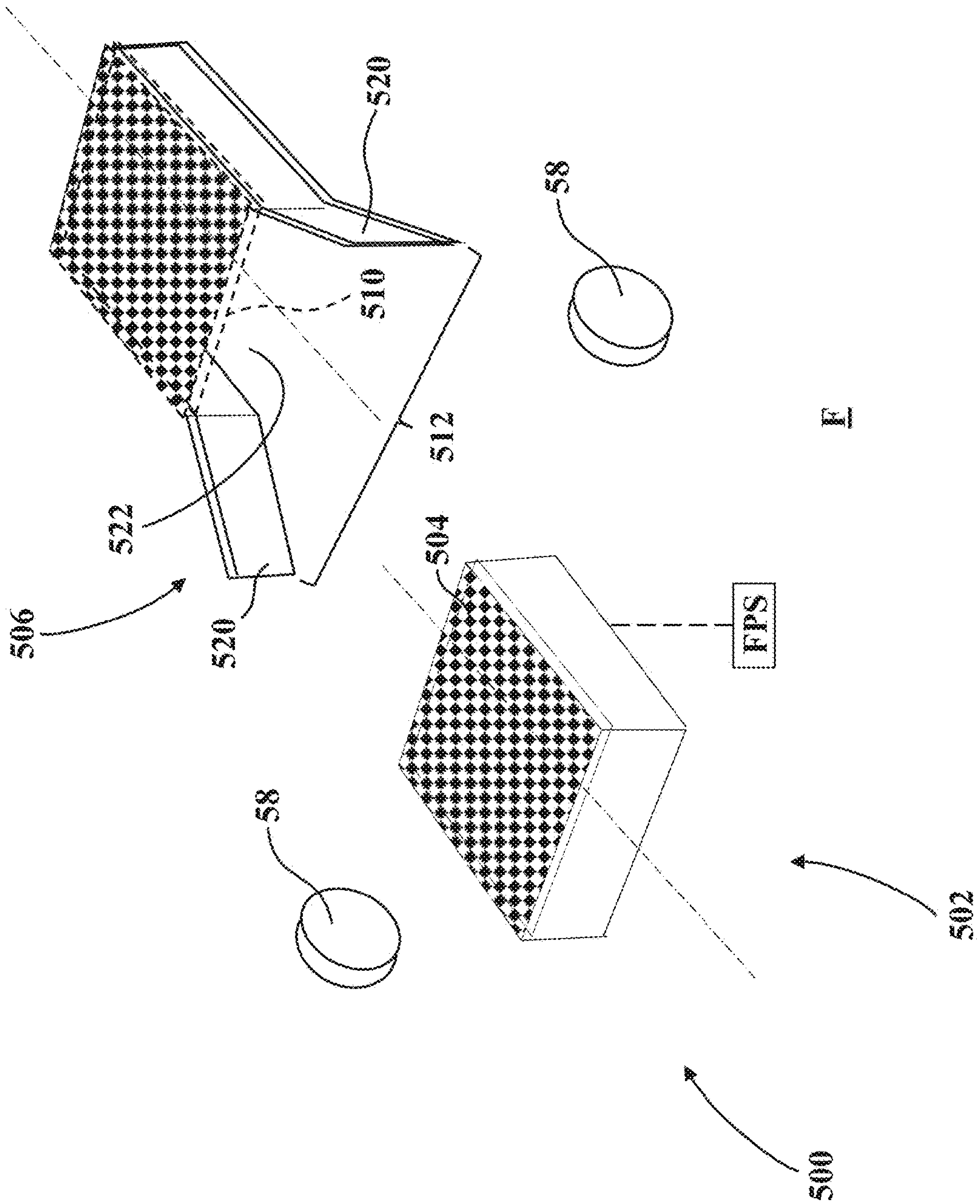


FIG. 14A

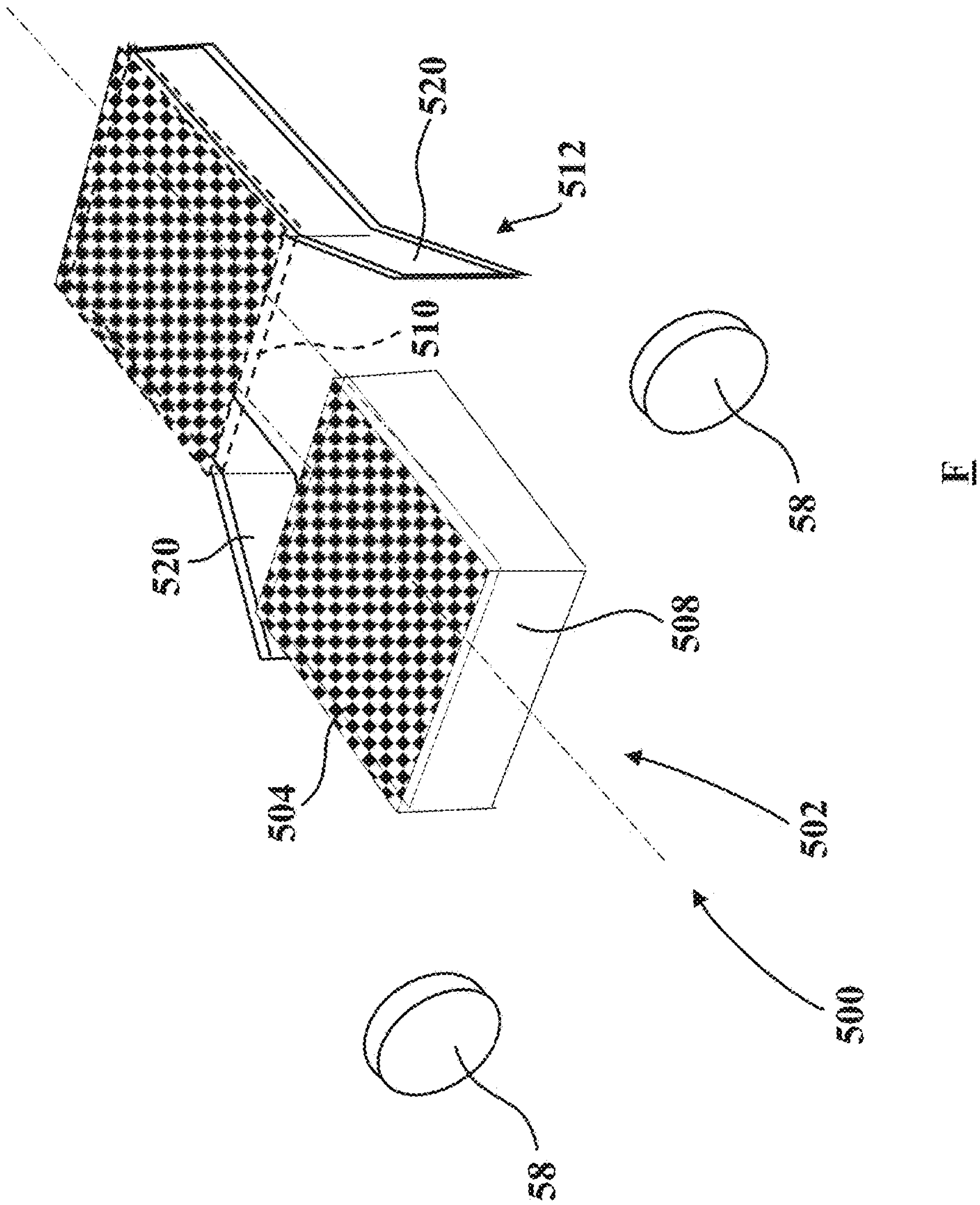


FIG. 14B

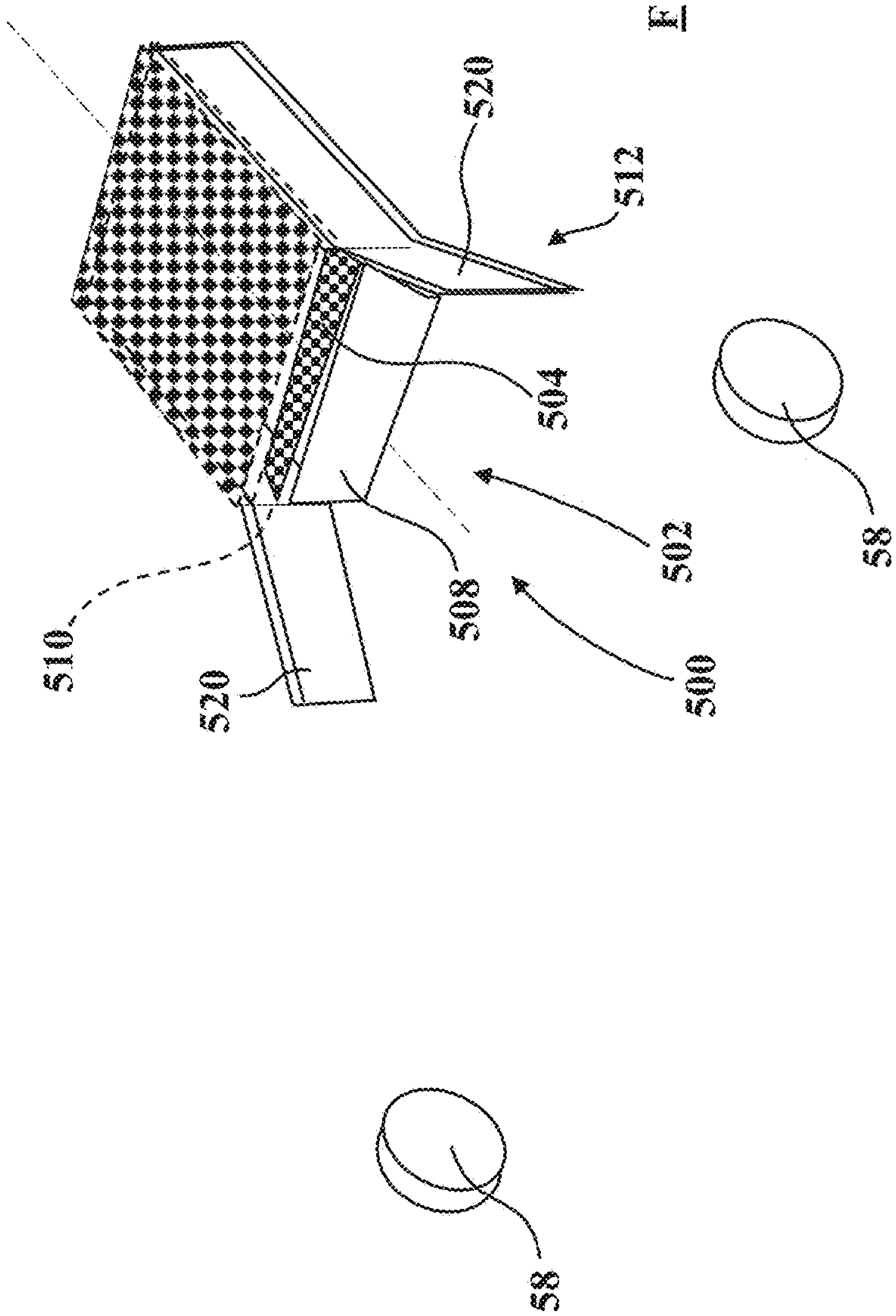


FIG. 14C

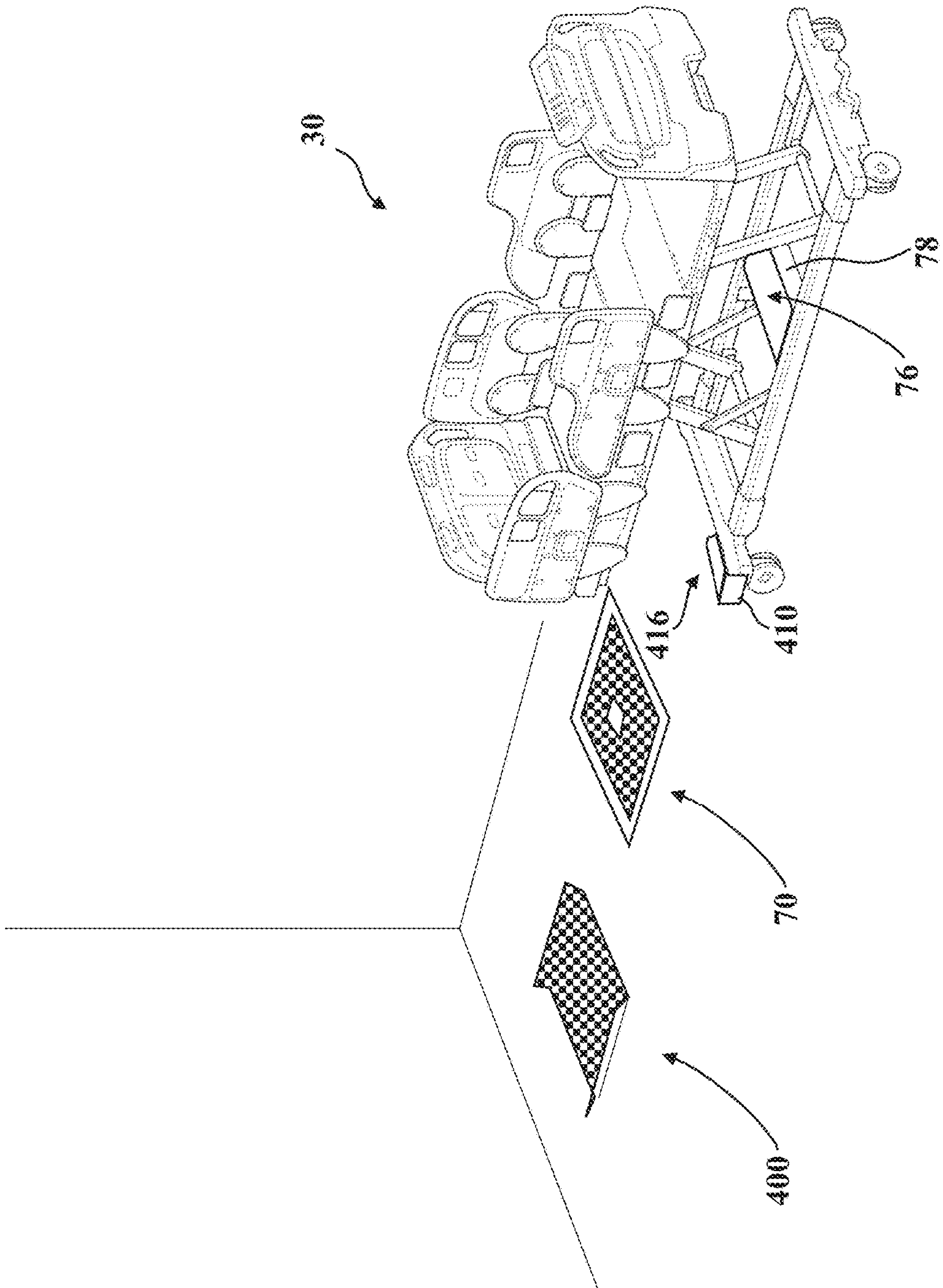


FIG. 15

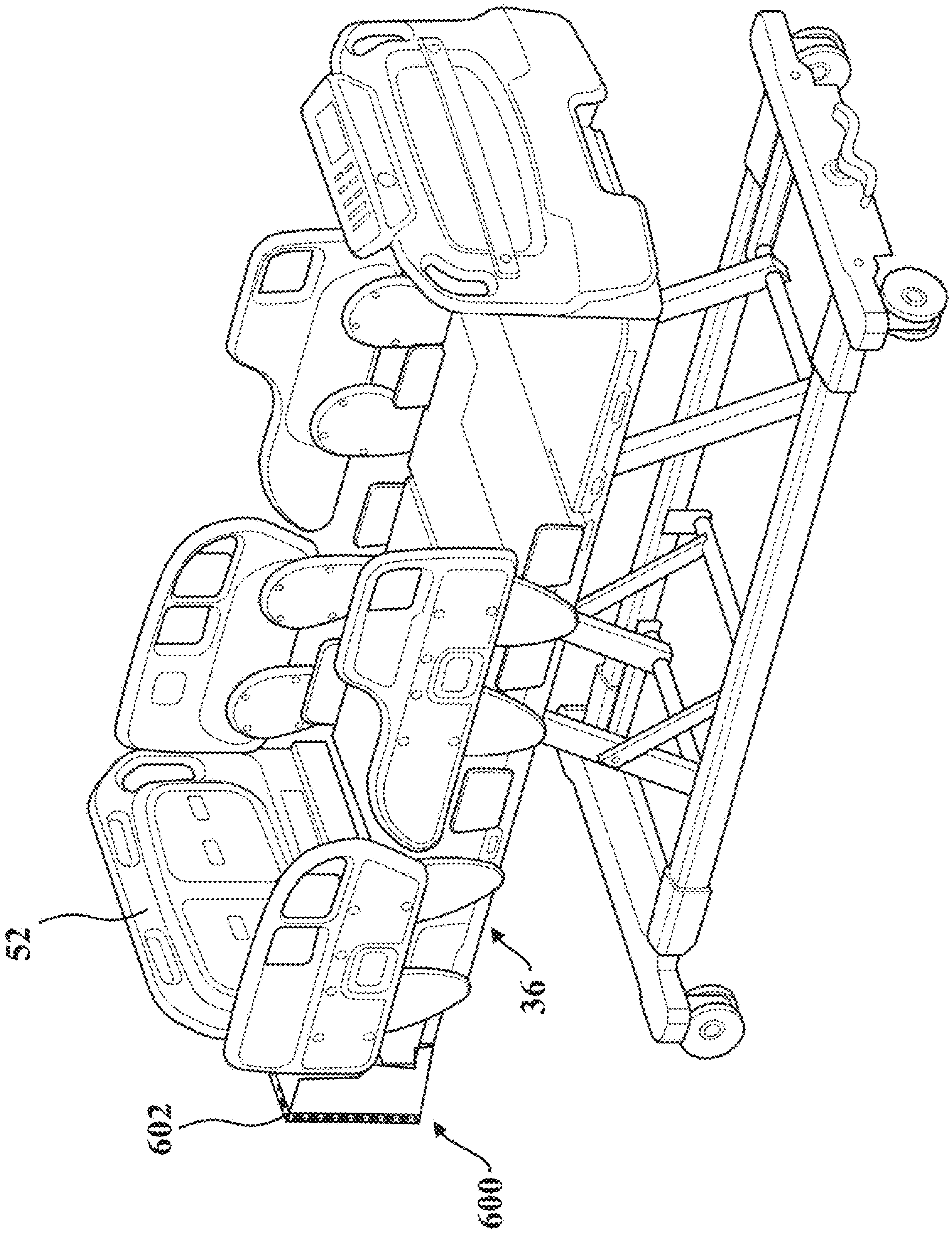


FIG. 16

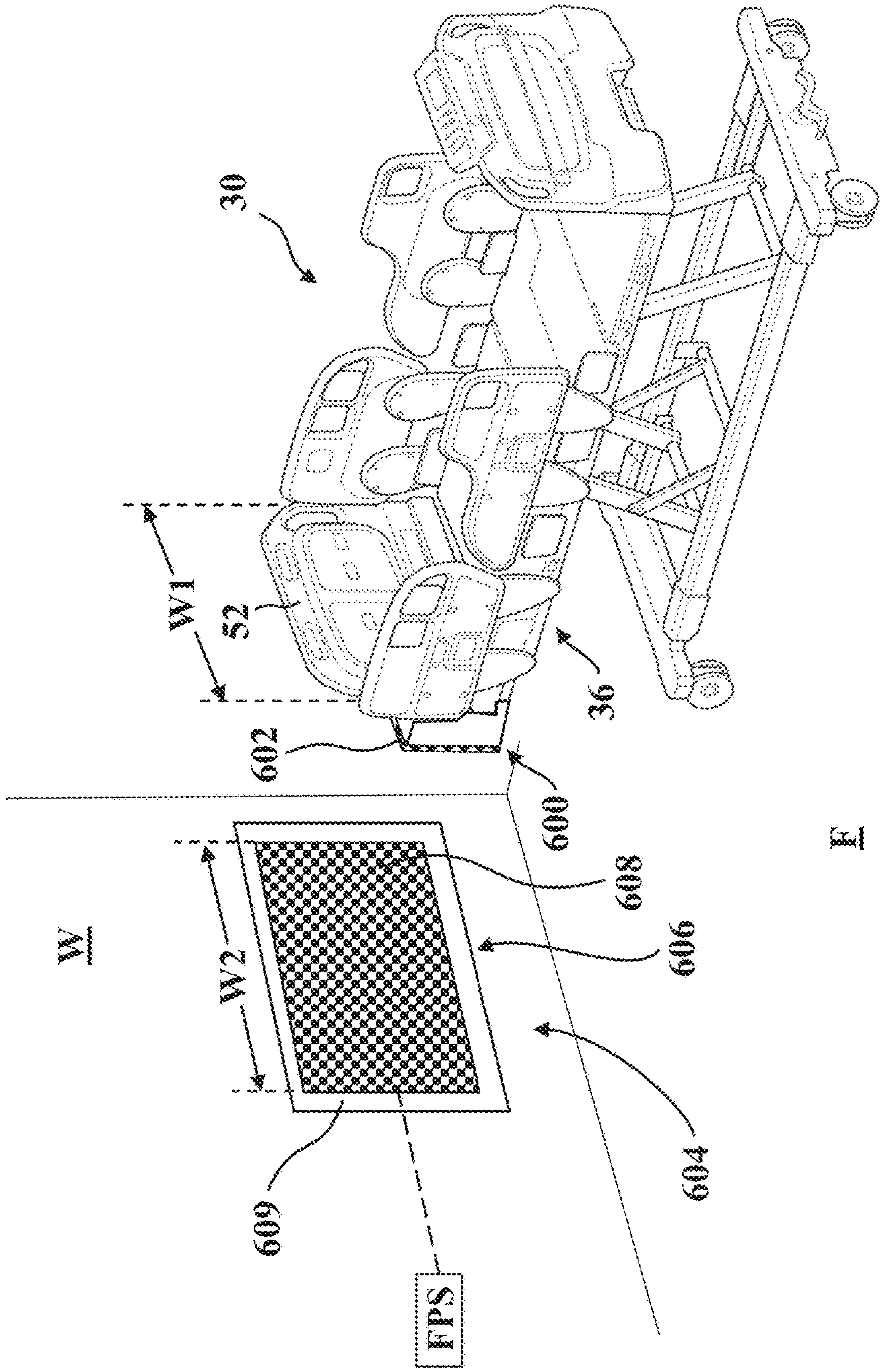


FIG. 17

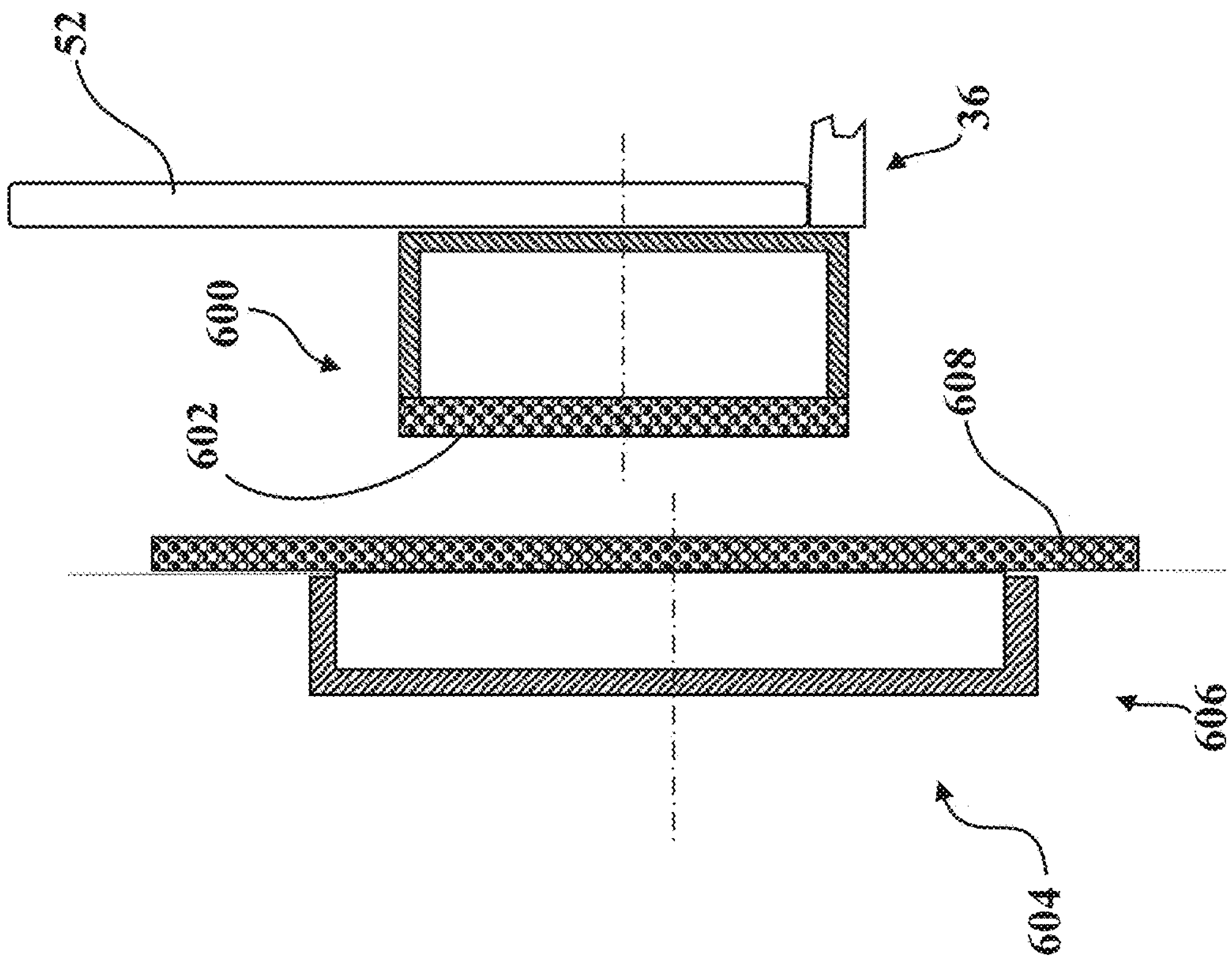


FIG. 18

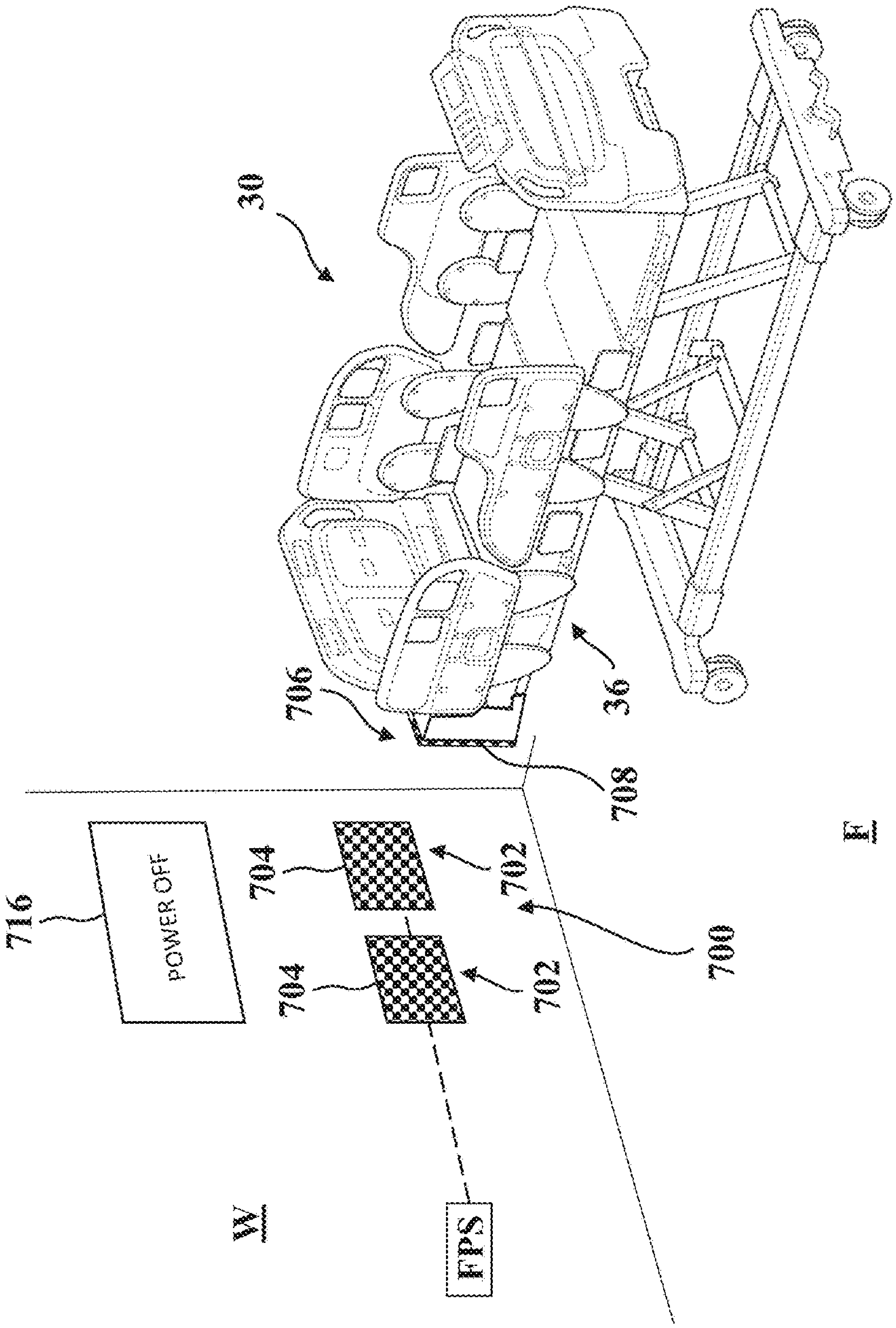


FIG. 19

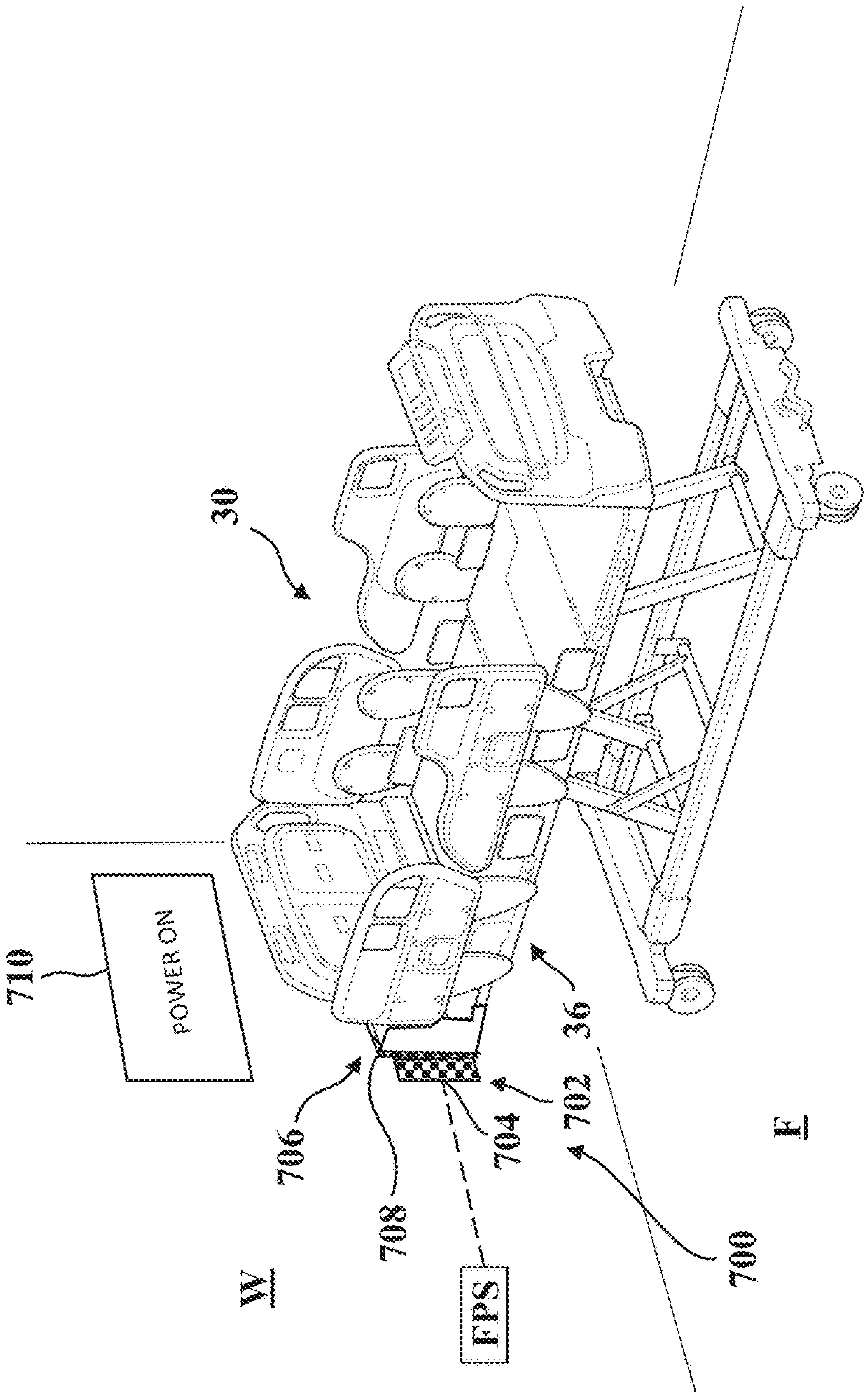


FIG. 20

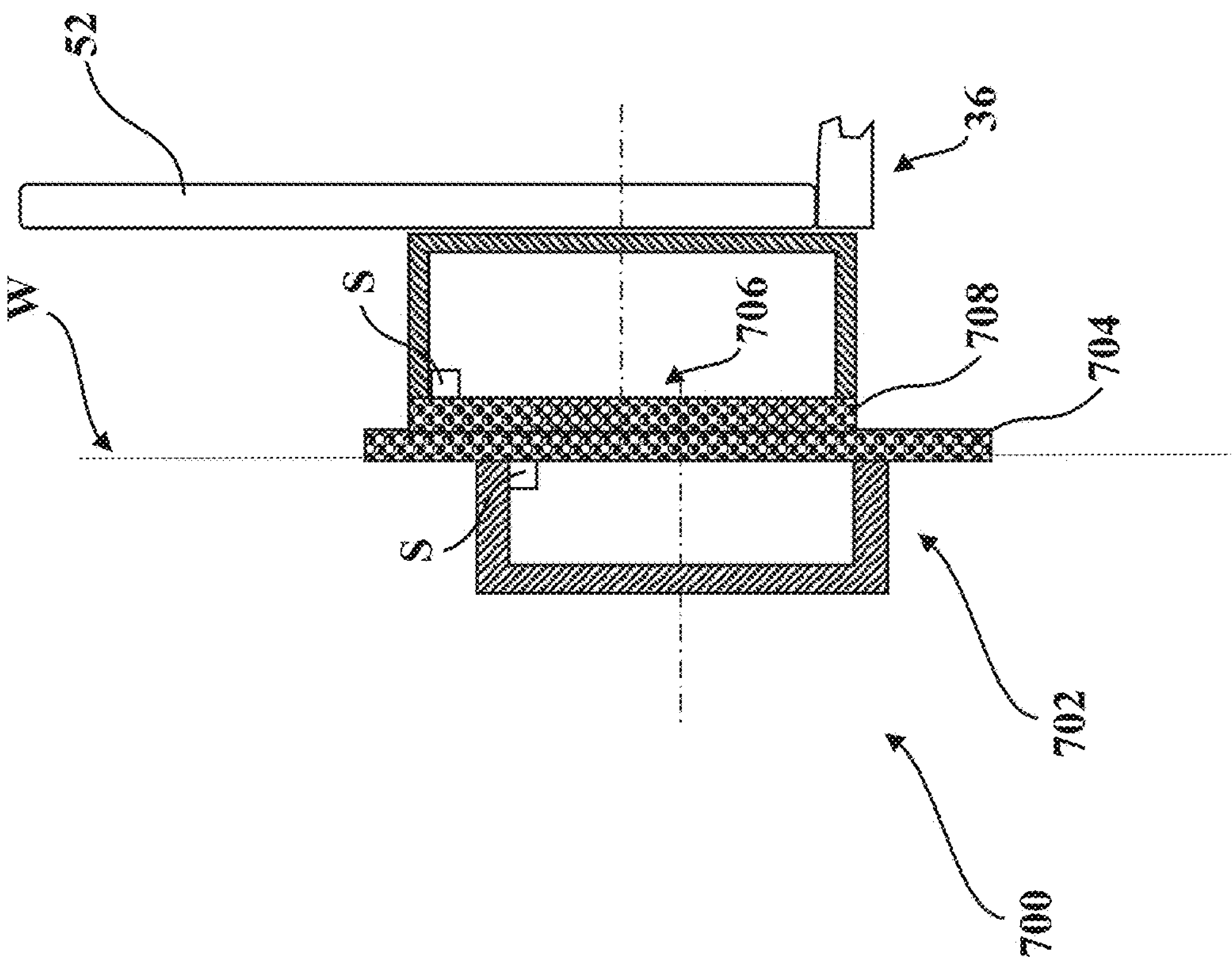


FIG. 21

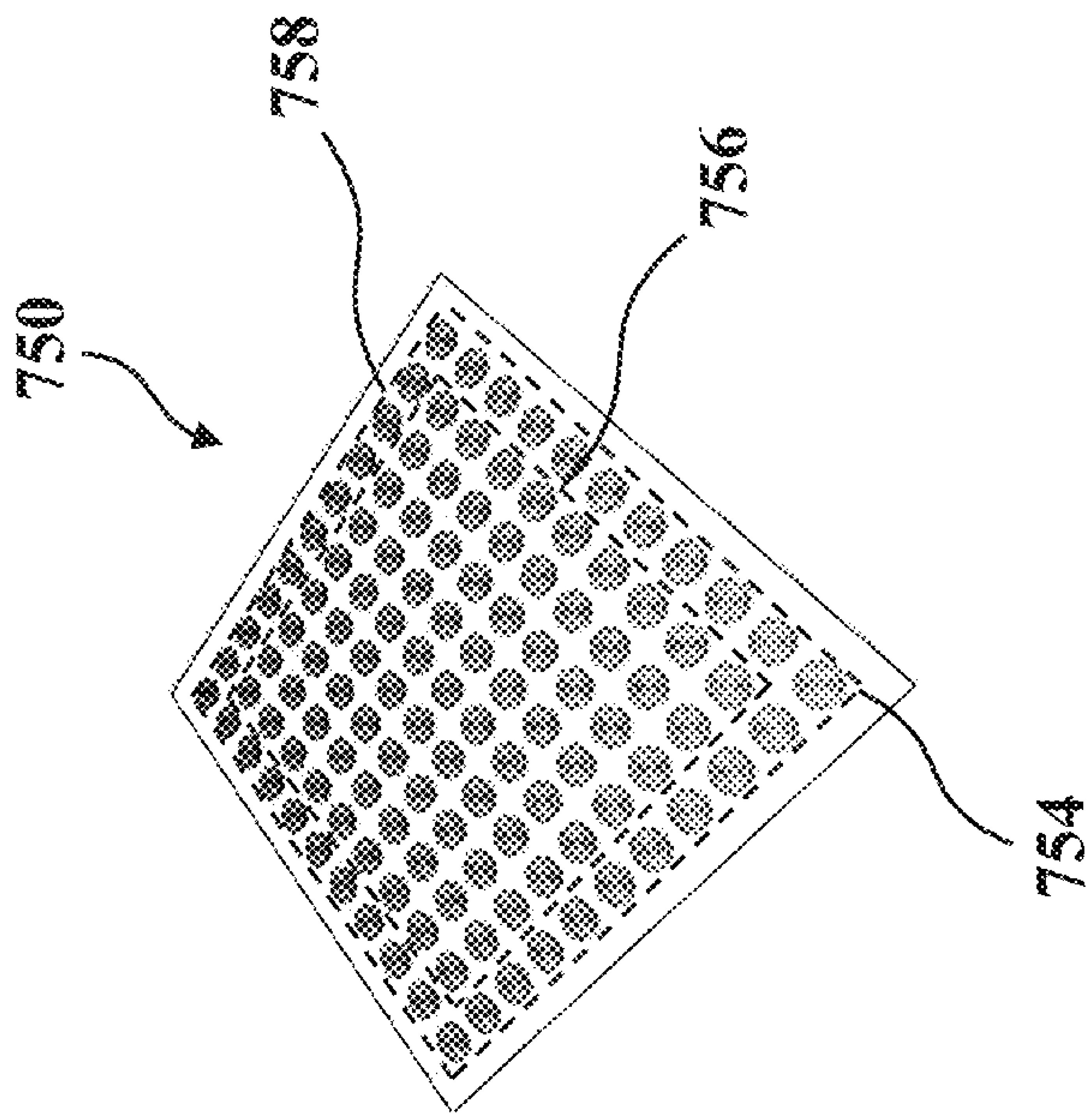


FIG. 22

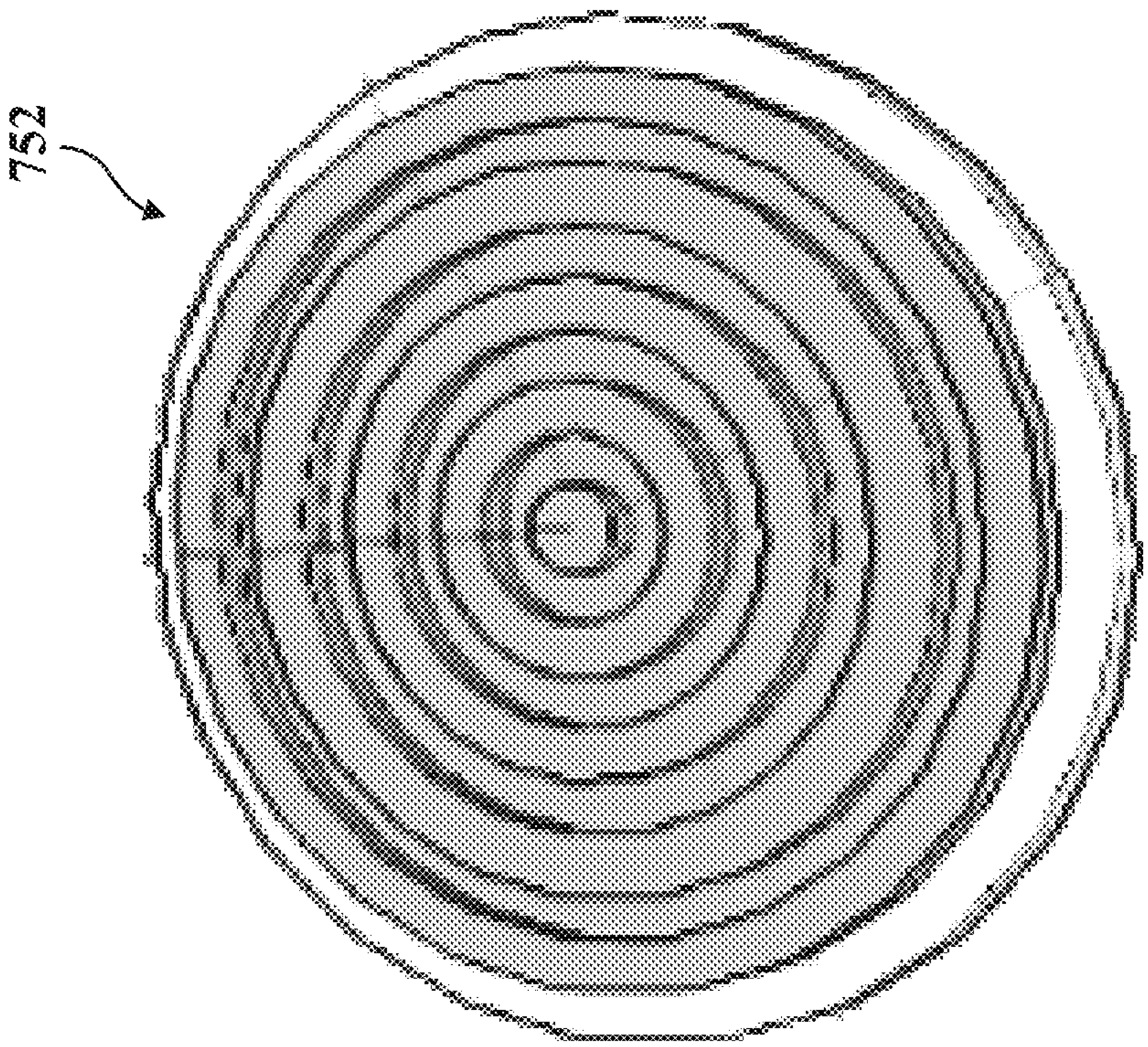


FIG. 23

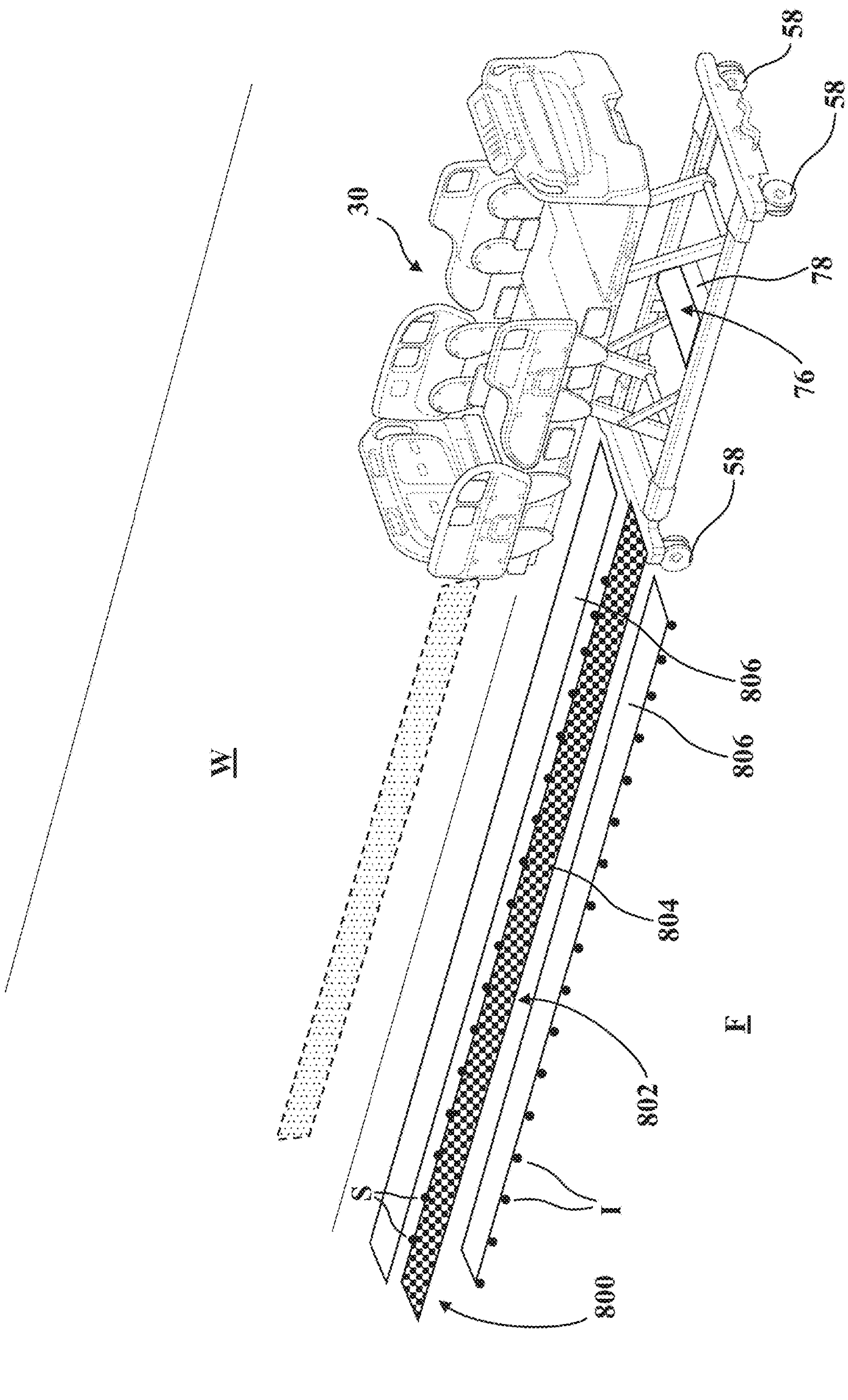


FIG. 24

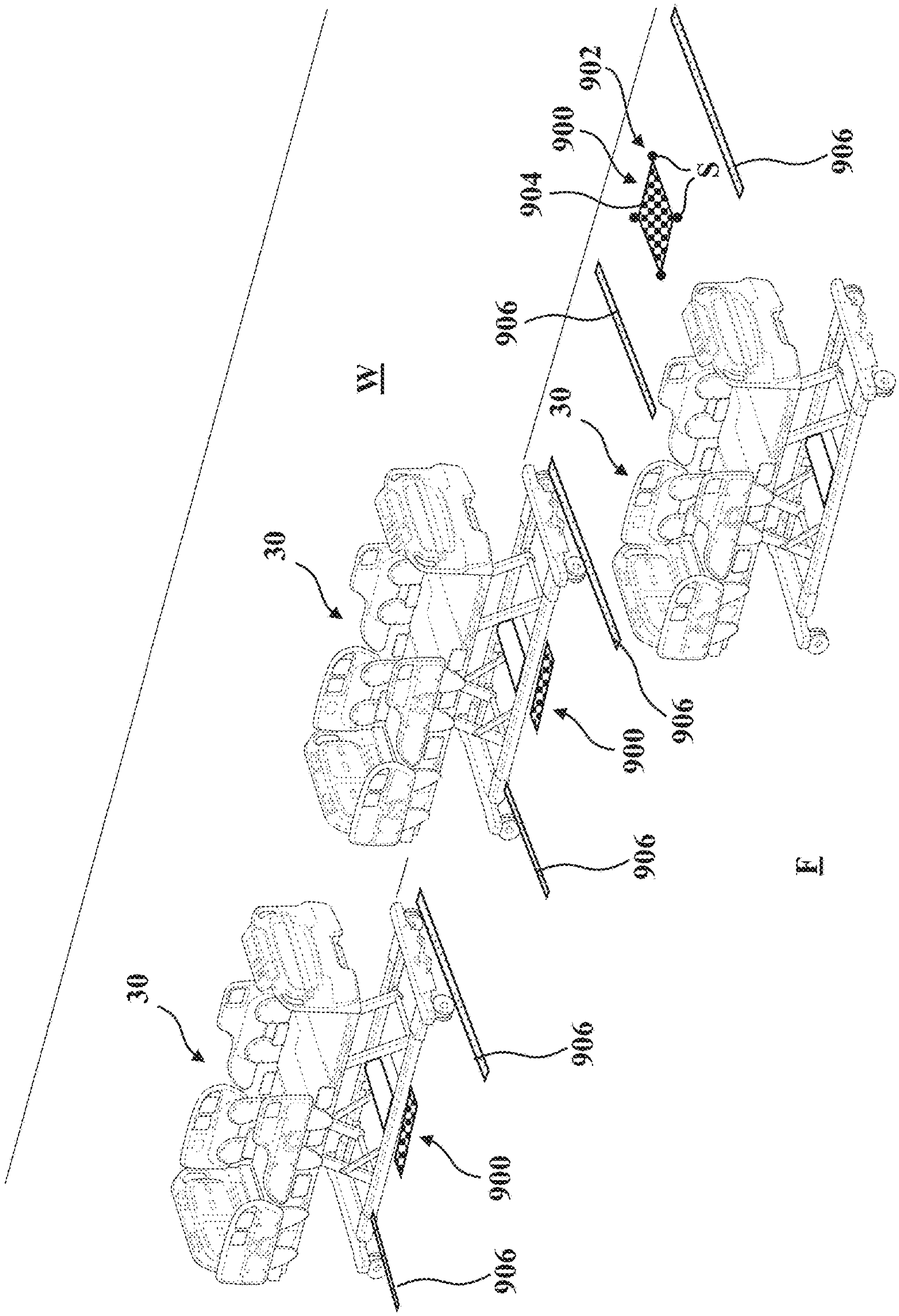
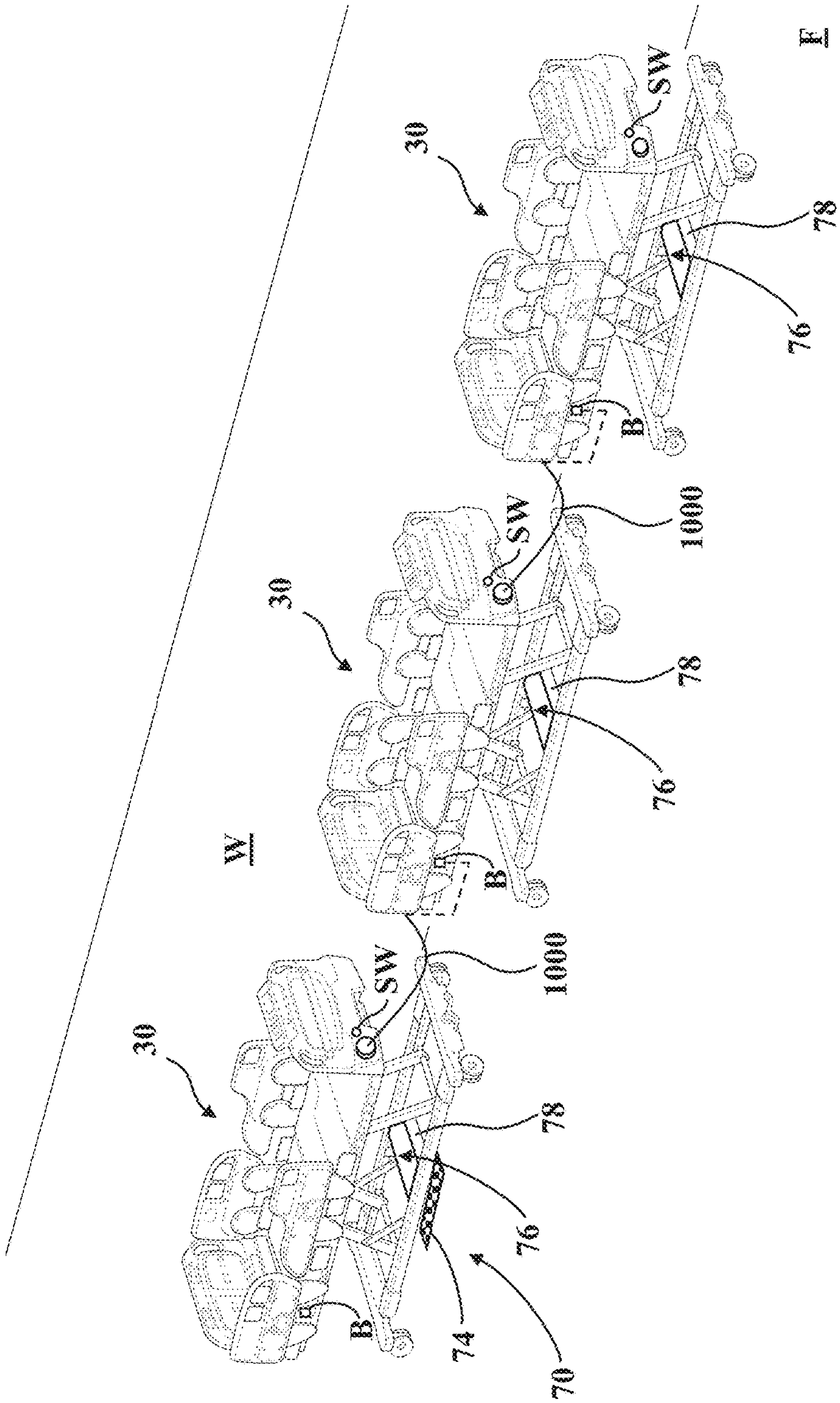


FIG. 25



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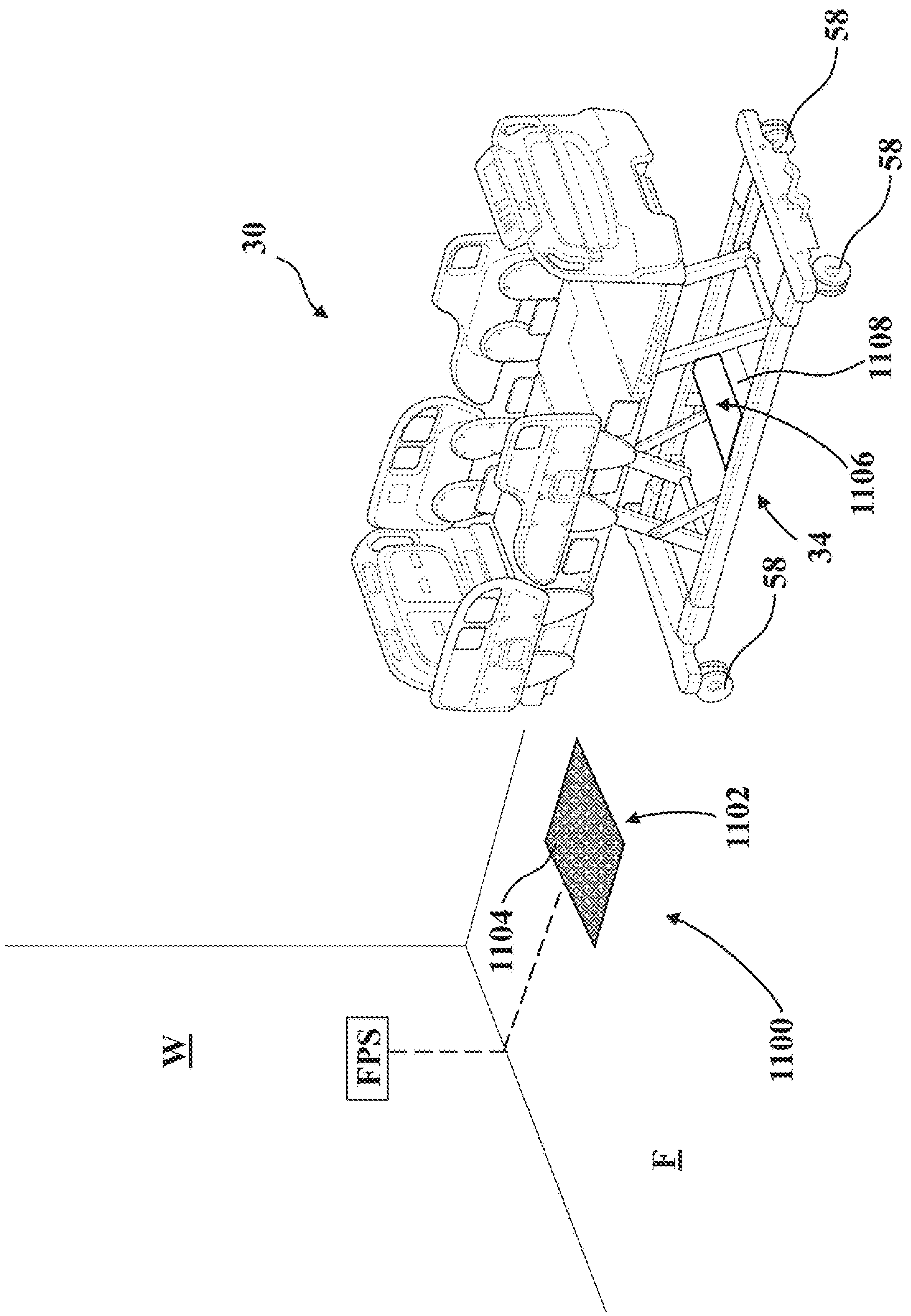

FIG. 27

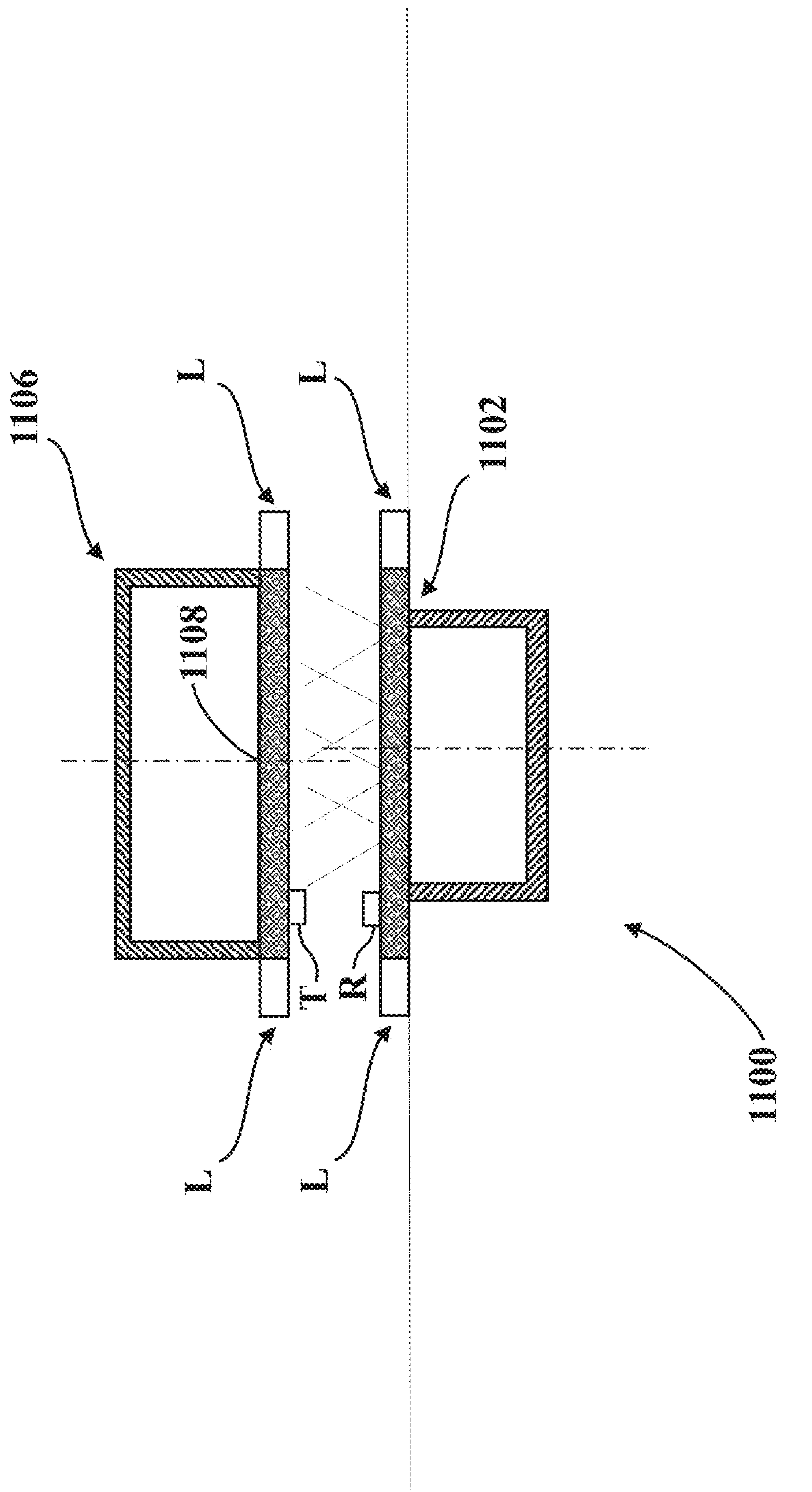

FIG. 28

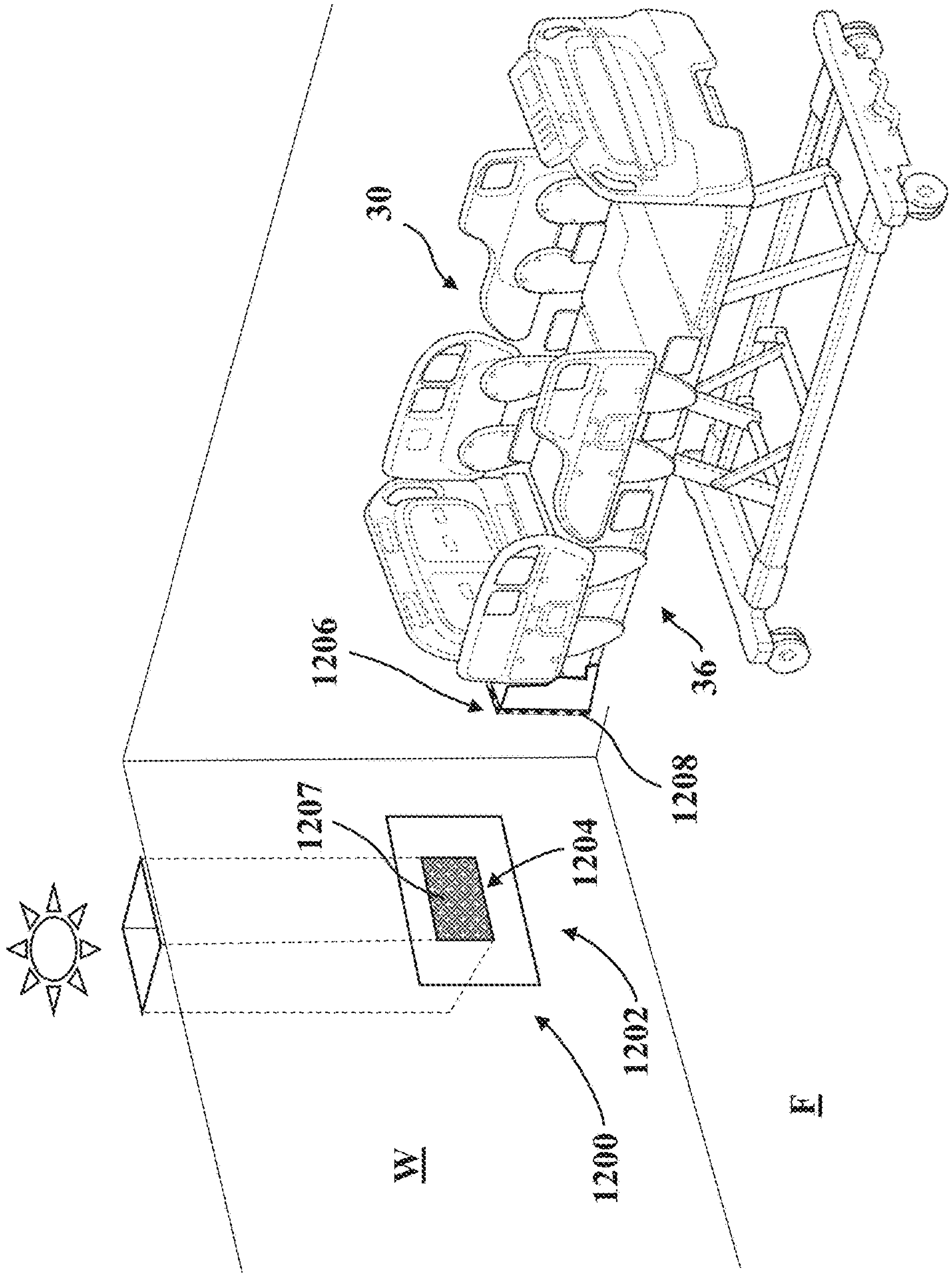

FIG. 29

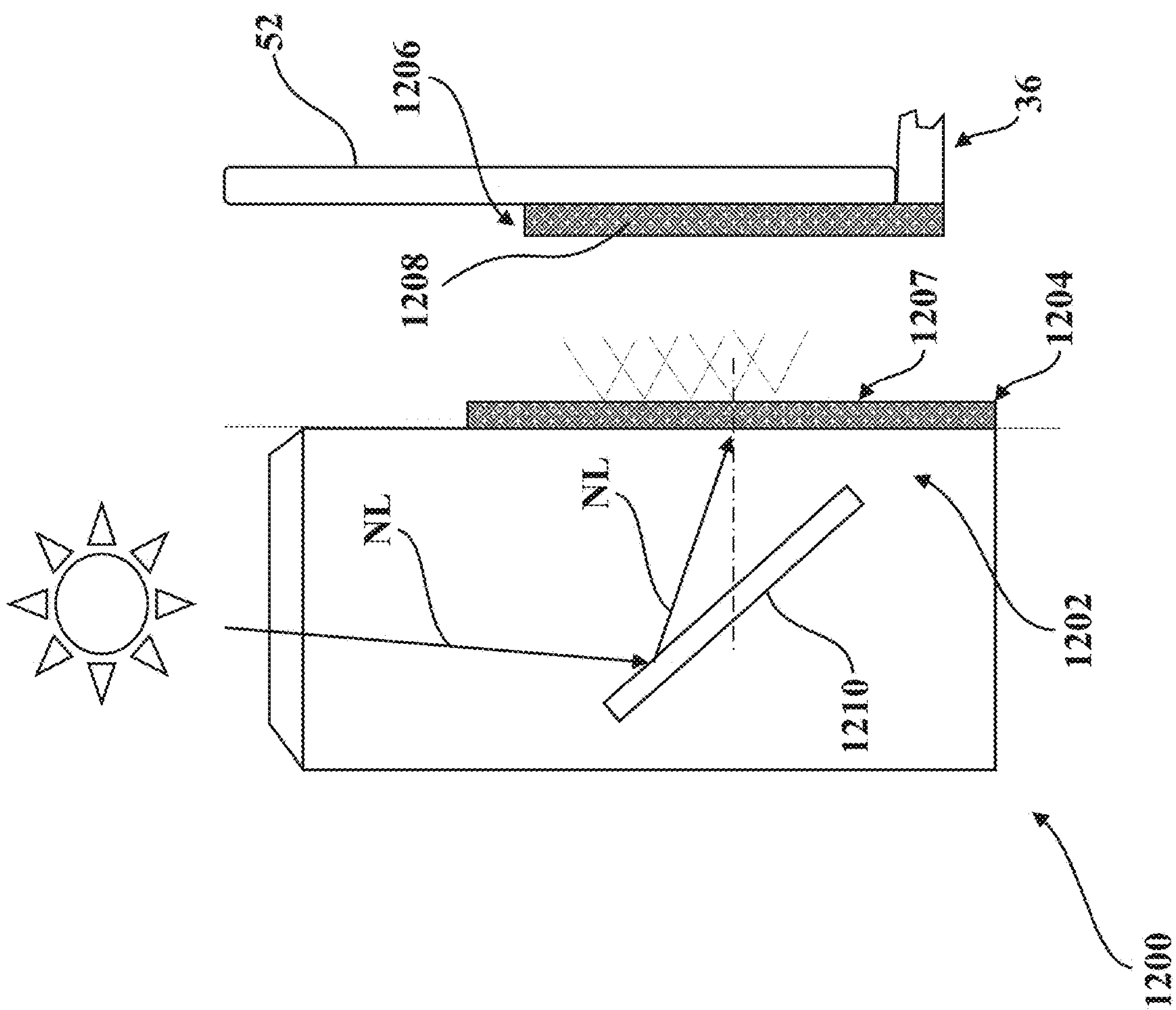

FIG. 30

POWER TRANSFER SYSTEM WITH PATIENT TRANSPORT APPARATUS AND POWER TRANSFER DEVICE TO TRANSFER POWER TO THE PATIENT TRANSPORT APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

The subject patent application is a Continuation of U.S. patent application Ser. No. 16/168,205, filed on Oct. 23, 2018, which claims priority to and all the benefits of U.S. Provisional Patent Application No. 62/576,315 filed on Oct. 24, 2017, the disclosures of each of which are hereby incorporated by reference in their entirety.

BACKGROUND

Patient transport apparatuses, such as hospital beds, stretchers, cots, tables, wheelchairs, and chairs facilitate care of patients in a health care setting. Conventional patient transport apparatuses comprise several electrically powered devices to carry out desired functions in caring for the patient. When the patient transport apparatus is located in a patient room, for instance, the patient transport apparatus is connected to a fixed power source, such as conventional wall outlet power, to provide energy to these electrically powered devices. Usually, a power cord is required to connect the patient transport apparatus to the wall outlet power. The patient transport apparatus also typically carries one or more batteries to provide energy to the electrically powered devices when the patient transport apparatus is unable to connect to the wall outlet power, such as during transport or when located outside of the patient room.

Patient care increasingly demands more and more attention from caregivers and any activities that distract the caregiver from the patient are undesirable—one such activity is plugging the power cord from the patient transport apparatus into the wall outlet power. Wireless power transfer methods have been suggested to simplify connecting to a power source. However, owing to the large (and often unwieldy) nature of many patient transport apparatuses, caregivers will likely have trouble aligning a wireless power receiver on the patient transport apparatus with a wireless power transmitter located in the patient's room. For instance, the caregiver may not have good line-of-sight to both the wireless power transmitter and the wireless power receiver and may be unable to visualize when alignment is achieved. Good alignment may be desirable to ensure efficient power transfer.

A power transfer system with a patient transport apparatus and power transfer device designed to overcome one or more of the aforementioned disadvantages is desired.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is perspective view of a patient transport apparatus with a power receiver assembly mounted to a base.

FIG. **2** is an illustration of the patient transport apparatus in relation to a power transfer device located in a floor.

FIG. **3** is a side elevational view of the power receiver assembly of the patient transport apparatus and a power transmitter assembly of the power transfer device.

FIG. **4** is a partial sectional view of the power transmitter assembly and the power receiver assembly.

FIG. **5** is a schematic view of a control system.

FIG. **6** is an illustration of a display screen showing that a power transmitter is not aligned with a power receiver.

FIG. **7** is an illustration of the display screen showing that the power transmitter is aligned with the power receiver.

FIG. **8** is a partial sectional view of an alternative power transmitter assembly and alternative power receiver assembly with locators.

FIG. **9**A is a perspective view of an alternative power transfer device with an integrated alignment system.

FIG. **9**B is a front side view of the power transfer device of FIG. **9**A.

FIG. **9**C is a left side view of the power transfer device of FIG. **9**A.

FIG. **10** is a perspective view of an alternative power transfer device with an alignment system comprising markings and stops on a floor surface.

FIG. **11** is a perspective view of an alternative power transfer device with an alignment system comprising raised side walls of the power transmitter.

FIG. **12** is a perspective view of the power transfer device of FIG. **11** being engaged by the patient transport apparatus.

FIG. **13** is a partial sectional view of the power transfer device of FIG. **11** being engaged by the patient transport apparatus.

FIGS. **14**A-**14**C are perspective views of an alternative alignment system to align a power transmitter with a power receiver.

FIG. **15** is a perspective view of multiple power transfer devices being employed to transfer power to multiple power receiver assemblies of the patient transport apparatus.

FIG. **16** is perspective view of an alternative patient transport apparatus with a power receiver assembly mounted to a support frame adjacent a headboard.

FIG. **17** is an illustration of the patient transport apparatus of FIG. **16** in relation to a power transfer device located in a wall.

FIG. **18** is a partial sectional view of the power transmitter assembly and the power receiver assembly of FIG. **17**.

FIG. **19** is an illustration of the patient transport apparatus of FIG. **16** in relation to an alternative power transfer device located in the wall.

FIG. **20** is an illustration of the patient transport apparatus of FIG. **19** engaging a power transmitter assembly of the power transfer device of FIG. **19**.

FIG. **21** is a partial sectional view of the power transmitter assembly and a power receiver assembly of the patient transport apparatus of FIG. **20**.

FIG. **22** is a perspective view of a power transmitter/power receiver having multiple modules of coils.

FIG. **23** is a perspective view of one of the modules.

FIG. **24** is a perspective view of an alternative power transfer device comprising a charging lane located on the floor surface.

FIG. **25** is a perspective view of a bank of power transfer devices for simultaneously transferring power to multiple patient transport apparatuses.

FIG. **26** is a perspective view of a power transfer device transferring power to multiple patient transport apparatuses via daisy-chained connections between the patient transport apparatuses.

FIG. **27** is a perspective view of an alternative power transfer device comprising a photovoltaic panel.

FIG. **28** is a partial sectional view of the photovoltaic panel transferring light energy to a power receiver of a patient transport apparatus.

FIG. **29** is a perspective view of an alternative power transfer system comprising an energy surface directing natural light to charge a photovoltaic panel on a patient transport apparatus.

FIG. **30** is an illustration of the natural light directed from the energy surface to the photovoltaic panel on the patient transport apparatus.

DETAILED DESCRIPTION

Referring to FIG. **1**, a patient transport apparatus **30** is shown for supporting a patient in a health care setting. The patient transport apparatus **30** illustrated in FIG. **1** comprises a hospital bed. In other embodiments, however, the patient transport apparatus **30** may comprise a stretcher, cot, table, wheelchair, chair, or similar apparatus utilized in the care of a patient.

A support structure **32** provides support for the patient. The support structure **32** illustrated in FIG. **1** comprises a base **34** and a support frame **36**. The base **34** comprises a base frame **35**. The support frame **36** is spaced above the base frame **35** in FIG. **1**. The support structure **32** also comprises a patient support deck **38** disposed on the support frame **36**. The patient support deck **38** comprises several sections, some of which are capable of articulating (e.g., pivoting) relative to the support frame **36**, such as a fowler section, a seat section, a thigh section, and a foot section. The patient support deck **38** provides a patient support surface **42** upon which the patient is supported.

A mattress (not shown) is disposed on the patient support deck **38** during use. The mattress comprises a secondary patient support surface upon which the patient is supported. The base **34**, support frame **36**, patient support deck **38**, and patient support surfaces **42** each have a head end and a foot end corresponding to designated placement of the patient's head and feet on the patient transport apparatus **30**. The base **34** comprises a longitudinal axis X along its length from the head end to the foot end. The base **34** also comprises a vertical axis V arranged crosswise (e.g., perpendicularly) to the longitudinal axis X along which the support frame **36** is lifted and lowered relative to the base **34**. The construction of the support structure **32** may take on any known or conventional design, and is not limited to that specifically set forth above. In addition, the mattress may be omitted in certain embodiments, such that the patient rests directly on the patient support surface **42**.

Side rails **44**, **46**, **48**, **50** are coupled to the support frame **36** and thereby supported by the base **34**. A first side rail **44** is positioned at a right head end of the support frame **36**. A second side rail **46** is positioned at a right foot end of the support frame **36**. A third side rail **48** is positioned at a left head end of the support frame **36**. A fourth side rail **50** is positioned at a left foot end of the support frame **36**. If the patient transport apparatus **30** is a stretcher or a cot, there may be fewer side rails. The side rails **44**, **46**, **48**, **50** are movable between a raised position in which they block ingress and egress into and out of the patient transport apparatus **30**, one or more intermediate positions, and a lowered position in which they are not an obstacle to such ingress and egress. In still other configurations, the patient transport apparatus **30** may not include any side rails.

A headboard **52** and a footboard **54** are coupled to the support frame **36**. In other embodiments, when the headboard **52** and footboard **54** are included, the headboard **52** and footboard **54** may be coupled to other locations on the patient transport apparatus **30**, such as the base **34**. In still other embodiments, the patient transport apparatus **30** does not include the headboard **52** and/or the footboard **54**.

Caregiver interfaces **56**, such as handles, are shown integrated into the footboard **54** and side rails **44**, **46**, **48**, **50** to facilitate movement of the patient transport apparatus **30** over floor surfaces. Additional caregiver interfaces **56** may be integrated into the headboard **52** and/or other components of the patient transport apparatus **30**. The caregiver interfaces **56** are graspable by the caregiver to manipulate the patient transport apparatus **30** for movement.

Other forms of the caregiver interface **56** are also contemplated. The caregiver interface may comprise one or more handles coupled to the support frame **36**. The caregiver interface may simply be a surface on the patient transport apparatus **30** upon which the caregiver logically applies force to cause movement of the patient transport apparatus **30** in one or more directions, also referred to as a push location. This may comprise one or more surfaces on the support frame **36** or base **34**. This could also comprise one or more surfaces on or adjacent to the headboard **52**, footboard **54**, and/or side rails **44**, **46**, **48**, **50**. In other embodiments, the caregiver interface may comprise separate handles for each hand of the caregiver. For example, the caregiver interface may comprise two handles.

Wheels **58** are coupled to the base **34** to facilitate transport over the floor surfaces. The wheels **58** are arranged in each of four quadrants of the base **34** adjacent to corners of the base **34**. In the embodiment shown, the wheels **58** are caster wheels able to rotate and swivel relative to the support structure **32** during transport. Each of the wheels **58** forms part of a caster assembly **60**. Each caster assembly **60** is mounted to the base **34**. It should be understood that various configurations of the caster assemblies **60** are contemplated. In addition, in some embodiments, the wheels **58** are not caster wheels and may be non-steerable, steerable, non-powered, powered, or combinations thereof. Additional wheels are also contemplated. For example, the patient transport apparatus **30** may comprise four non-powered, non-steerable wheels, along with one or more powered wheels. In some cases, the patient transport apparatus **30** may not include any wheels.

In other embodiments, one or more auxiliary wheels (powered or non-powered), which are movable between stowed positions and deployed positions, may be coupled to the support structure **32**. In some cases, when these auxiliary wheels are located between caster assemblies **60** and contact the floor surface in the deployed position, they cause two of the caster assemblies **60** to be lifted off the floor surface thereby shortening a wheel base of the patient transport apparatus **30**. A fifth wheel may also be arranged substantially in a center of the base **34**.

The patient transport apparatus **30** comprises one or more electrically powered devices PD (see FIG. **5**) that are employed to perform one or more functions of the patient transport apparatus **30** in caring for the patient. Such powered devices PD may comprise, for example, electric actuators, electric motors, electronic displays, electronic user interfaces, electronic therapy devices, communication devices, lighting systems, and the like. When the patient transport apparatus **30** is stationary for long periods of time, such as when the patient transport apparatus **30** is located in a patient room, a fixed power source FPS may be employed to provide energy to the powered devices PD. The fixed power source FPS may be conventional facility power routed throughout a facility, such as a hospital. An energy storage device B (see FIG. **5**) is located on the patient transport apparatus **30** to store energy utilized to power these powered devices PD, particularly when the patient transport apparatus **30** is being transported away from the patient room. The energy storage device B may comprise batteries, capacitors, and the like. The energy storage device B requires charging from time-to-time via the fixed power source FPS, as described further below.

As shown in FIG. **2**, a power transfer system transfers energy from the fixed power source FPS to the patient transport apparatus **30**. The power transfer system comprises a power transfer device **70** provided to transfer power to a power receiver assembly **76** on the patient transport apparatus **30**. Referring to FIG. **3**, the power transfer device **70** comprises a power transmitter assembly **72** with a power transmitter **74** configured to transfer power to the power receiver assembly **76**. The power receiver assembly **76** comprises a power receiver **78**. The power transmitter **74** is coupled to the fixed power source FPS and the power receiver **78** is coupled to the powered devices PD and the energy storage device B on the patient transport apparatus **30** (see FIG. **5**). In one embodiment, the power transmitter **74** is configured to transfer power wirelessly to the power receiver **78**, such as through inductive coupling.

The power transmitter **74** may comprise one or more coils and the power receiver **78** may comprise one or more coils. The coils of the power transmitter **74** create a magnetic field that, when the coils of the power receiver **78** are positioned nearby, creates electrical current within the coils of the power receiver **78** and within any electrical connections to the power receiver **78**. The patient transport apparatus **30** harnesses the electrical energy inductively generated within the coils of the power receiver **78** for providing electrical power to the electrically powered devices PD directly or indirectly, such as through the energy storage device B. Various sizes, shapes, and types of coils of the power transmitter **74** and/or the power receiver **78** are contemplated.

In the embodiment shown in FIGS. **3** and **4**, the power receiver **78** is coupled to the base **34** of the support structure **32**. However, the power receiver **78** may be located at any suitable location on the patient transport apparatus **30**. In other embodiments, the power receiver **78** is mounted to the support frame **36**. The power transfer device **70** is located on the floor surface F in FIG. **3** and may be in the form of a mat as shown, or may be integrated into the floor. The power transfer device **70** may be located at any suitable location to transfer power to the power receiver **78**. In other embodiments, the power transfer device **70** is located adjacent to a wall surface W and may be embodied in a pad attached to the wall surface W, or may be integrated into the wall.

Referring to FIG. **5**, a control system is provided to control operation of the patient transport apparatus **30** and the power transfer device **70**. The control system comprises an apparatus controller **90** and a power transfer controller **92**. Each of the controllers **90**, **92** have one or more microprocessors, microcontrollers, field programmable gate arrays, systems on a chip, discrete circuitry, and/or other suitable hardware, software, or firmware that is capable of carrying out the functions described herein. The controllers **90**, **92** may communicate with a network via one or more communication devices C, which may be wireless transceivers that communicate via one or more known wireless communication protocols such as WiFi, Bluetooth, Zigbee, and the like. Wired communication is also contemplated. Additionally, the controllers **90**, **92** may communicate with each other via the communication devices C such that the apparatus controller **90** could be configured to carry out all the functions of the power transfer controller **92** described herein, and vice versa. In some cases, only a single controller is needed to perform the functions recited herein.

The apparatus controller **90** may be carried on-board the patient transport apparatus **30**, or may be remotely located. In one embodiment, the apparatus controller **90** is mounted to the base **34**. In other embodiments, the apparatus controller **90** is mounted to the footboard **54**. The apparatus controller **90** is coupled to the powered devices PD in a manner that allows the apparatus controller **90** to control the powered devices PD (connections shown schematically in FIG. **5**). The apparatus controller **90** is also coupled to the power receiver assembly **76** to control operation of the power receiver **78**. The apparatus controller **90** may communicate with the powered devices PD, power receiver **78**, and/or other components via wired or wireless connections to perform one of more desired functions. The power transfer controller **92** is coupled to the power transmitter assembly **72** to control operation of the power transmitter **74**. The power transfer controller **92** may communicate with the power transmitter **74** and/or other components via wired or wireless connections to perform one or more desired functions.

The controllers **90**, **92** are configured to process instructions or to process algorithms stored in memory to control operation of the power transmitter **74** and/or the power receiver **78**, or to control other electronic components described herein.

The user, such as a caregiver, may actuate a user input device UI (see FIG. **5**), which transmits a corresponding input signal to the apparatus controller **90** and/or the transfer controller **92** to initiate power transfer from the power transmitter **74** to the power receiver **78**. The user input devices UI may comprise any device capable of being actuated by the user. The user input devices UI may be configured to be actuated in a variety of different ways, including but not limited to, mechanical actuation (hand, foot, finger, etc.), hands-free actuation (voice, foot, etc.), and the like. The patient transport apparatus **30** may also comprise user input devices UI to actuate the powered devices PD. The user input devices UI may comprise buttons, such as separate buttons corresponding to lift, lower, Trendelenburg, reverse Trendelenburg, raise back section, lower back section, raise leg section, lower leg section, raise foot section, lower foot section, etc.

The user input devices UI may also comprise a gesture sensing device for monitoring motion of hands, feet, or other body parts of the user (such as through a camera), a microphone for receiving voice activation commands, a foot pedal, and a sensor (e.g., infrared sensor such as a light bar or light beam to sense a user's body part, ultrasonic sensor, etc.). Additionally, the buttons/pedals can be physical buttons/pedals or virtually implemented buttons/pedals such as through optical projection or on a touchscreen. The buttons/pedals may also be mechanically connected or drive-by-wire type buttons/pedals where a user applied force actuates a sensor, such as a switch or potentiometer. It should be appreciated that any combination of user input devices I may also be utilized. The user input devices UI may be located on one of the side rails **44**, **46**, **48**, **50**, the headboard **52**, the footboard **54**, or other suitable locations. The user input devices UI may also be located on a portable electronic device (e.g., iWatch®, iPhone®, iPad®, or similar electronic devices).

Referring to FIGS. **3** through **7**, an alignment system **100** is provided to align the power transmitter **74** with the power receiver **78** so that efficient energy transfer occurs from the power transmitter **74** to the power receiver **78**. Alignment may comprise any alignment between the power transmitter **74** and the power receiver **78**, such as vertical alignment, longitudinal alignment, lateral alignment, combinations thereof, and the like. Alignment may also comprise distance alignment, e.g., placing the power transmitter **74** within a desired distance of the power receiver **78** and/or may comprise orientation alignment so that the coils of the power receiver **78** are in a desired orientation to the coils of the power transmitter **74**. Other forms of alignment are also contemplated. In some cases, the distance between the coils of the power transmitter **74** and coils of the power receiver **78** is desired to be less than a wavelength of the frequency used for inductive coupling to ensure effective energy transfer. Orientations in which a large amount of magnetic field passes through the coils of the power receiver **78** may be desired for high energy transfer efficiency.

In the embodiments described herein, the power transmitter **74** is generally fixed with respect to the floor surface F and/or the wall surface W. Likewise, the power receiver **78** is generally fixed to the support structure **32**, or other component of the patient transport apparatus **30**. However, the power receiver **78** may be movable by virtue of a lift mechanism of the patient transport apparatus **30**, or other movable components of the patient transport apparatus **30**, such as when the power receiver **78** is located on the support frame **36**, which can be lifted or lowered relative to the base **34**. Nevertheless, alignment between the power transmitter **74** and the power receiver **78** is carried out by providing various forms of guidance to the user to guide the patient transport apparatus **30** into correct positioning relative to the power transfer device so that the power transmitter **74** and the power receiver **78** are aligned as needed.

Referring to FIGS. **3** and **4**, the alignment system **100** comprises one or more locators L configured to locate one or more of the power receiver **78** and the power transmitter **74**. The locators L facilitate alignment of the power transmitter **74** and the power receiver **78** by providing feedback to the user so that the user is able to reposition the patient transport apparatus **30** as needed, usually by wheeling the patient transport apparatus **30** in a desired manner to accomplish desired alignment. The locators L may comprise sensors coupled (e.g. wired or wirelessly) to the apparatus controller **90** and/or power transfer controller **92**. The sensors are configured to sense the one or more of the power receiver **78** and the power transmitter **74** to facilitate alignment of the power transmitter **74** and the power receiver **78**. The locators L may also comprise one or more markers to be sensed by the sensors to determine relative alignment between the power transmitter **74** and the power receiver **78**. In many cases, the controllers **90**, **92** utilize signals from the locators L to generate feedback to the user to achieve desired alignment of the power transmitter **74** and the power receiver **78**.

In this embodiment, the locators L comprise an optical sensor in the form of a camera CAM (e.g., video camera) and a corresponding marker MAR located in a center of the power transmitter **74**. Alignment is achieved once the camera CAM is able to view the corresponding marker MAR at a desired location. For example, referring to FIGS. **6** and **7**, a display **102** of the patient transport apparatus **30** may be used to show a real-time image from the camera CAM so the user can align the marker MAR in a cross-hair on the display **102** to align the power transmitter **74** with the power receiver **78**. The display **102** may be mounted on the footboard **54** or other part of the patient transport apparatus **30** and/or may form part of a user interface UI.

Misalignment of the power transmitter **74** and power receiver **78** is indicated in FIG. **6**. In this case, the current alignment of power transmitter **74** and the power receiver **78** (e.g, the marker MAR is at least visible in the image displayed albeit not centered) may be satisfactory for some power transfer to occur, but not at a desired transfer rate. After the user moves the patient transport apparatus **30** to move the cross-hair over the marker MAR so that the marker MAR is centered in the cross-hair, desired alignment is achieved, as shown in FIG. **7**. When the desired alignment is reached, the power transfer controller **92** is configured to activate the power transmitter **74** either automatically, or in response to user input. The power transfer controller **92** may automatically activate the power transmitter **74** based on pattern recognition and the location of the marker MAR being at a center of the image taken by the camera CAM. A piezoelectric element, motor with eccentric weight, or other tactile indicator, for example, could be coupled to the apparatus controller **90** and/or the power transfer controller **92** to be activated once alignment is achieved to provide a tactile response to the user that the power transmitter **74** is aligned with the power receiver **78**.

Referring to FIG. **8**, in another embodiment, the locators L may comprise hall-effect sensors S and corresponding magnets MAG wherein the hall-effect sensors S generate variable signals based on the relative alignment of the magnets MAG with the hall-effect sensors S. For instance, hall-effect sensors S may be connected to the power transmitter **74** while magnets MAG are connected to the power receiver **78**. When all the magnets MAG are in desired alignment with their corresponding hall-effect sensor S (e.g, around a periphery of the power transmitter **74**/power receiver **78**), then corresponding alignment signals from all the hall-effect sensors S will be received by the power transfer controller **92** indicating that desired alignment has been achieved. Other ways of verifying alignment and providing corresponding alignment feedback to the controllers **90**, **92** have been contemplated.

The display **102** can similarly be used to provide feedback to the user based on the signals from the hall-effect sensors S to help guide the user's movement of the patient transport apparatus **30**. For instance, the display **102** could show the locations of the magnets MAG relative to the hall-effect sensors S with instructions to the user as to how the patient transport apparatus **30** should be moved to achieve alignment. The instructions could be audible, visual, tactile, and the like. The instructions could comprise directional instructions (e.g., "move forward," "move rearward," "move left," "move right," etc.), distance instructions (e.g., "move 10 inches forward"), and/or other forms of instructions, such as graphical displays showing current positioning and desired positioning, and the like. A piezoelectric element, motor with eccentric weight, or other tactile indicator, for example, could be coupled to the apparatus controller **90** and/or the power transfer controller **92** to be activated once alignment is achieved to provide a tactile response to the user that the power transmitter **74** is aligned with the power receiver **78**.

Referring back to the schematic diagram of FIG. **5**, sensors S are also configured to determine if power is being transferred from the power transmitter **74** to the power receiver **78**. In some cases, only one sensor is used. The sensor S may be coupled to the apparatus controller **90** and the power receiver **78** to generate a signal that varies in response to the power receiver **78** being energized during power transfer. A separate sensor S may also be connected to the power transfer controller **92** and used to verify that the coils of the power transmitter **74** are active—to avoid a false signal from the sensor S associated with the power receiver **78**. The sensors S may also be able to determine, through connection to the apparatus controller **90** and/or the power transfer controller **92**, a quality parameter of power transfer associated with alignment of the power transmitter **74** and the power receiver **78**, such as the efficiency of power transfer wherein higher efficiency means that more energy is being transferred per unit time because of better alignment. The quality parameter can be measured, for instance, by sensing current/voltage produced in the power receiver **78** resulting from the power transfer or by measuring some other power transfer related parameter. The controllers **90**, **92** may be configured to provide audible, visual, and/or tactile feedback to the user based on feedback from the sensors S to increase the efficiency of power transfer. In other words, alignment can be improved by the user based on feedback to increase efficiency by better aligning the power receiver **78** with the magnetic field generated by the power transmitter **74**. The sensors S may comprise one or more of the coils of the power receiver **78** and/or the coils of the power transmitter **74**, separate coils connected to the apparatus controller **90** and/or power transfer controller **92**, sensors (e.g., circuits) to measure current and/or voltage, hall-effect sensors to sense changes in magnetic field, and the like.

One or more additional sensors S coupled to the apparatus controller **90** and the energy storage device B may be configured to sense charging of the energy storage device B as the energy storage device B is being charged by the power transmitter **74** through the power receiver **78** during inductive power transfer. The apparatus controller **90** may be configured to analyze signals from the sensor S and to modify operational parameters of the power transmitter **74** to account for sensed charging activity, e.g., by changing which coils are energized, modifying applied voltages, instructing the user to move the patient transport apparatus **30**, etc., to improve the charging speed/efficiency of the energy storage device B.

One or more indicators I are coupled to the apparatus controller **90** and/or the power transfer controller **92**. The indicators I are arranged to indicate that power is being transferred from the power transmitter **74** to the power receiver **78** based on the signals from the sensors S, to indicate whether desired alignment has been reached, and/or to indicate the quality parameter of the power transfer. The indicators I could be used in any of the embodiments described herein for this purpose. The indicators I comprise one or more of a visual indicator, an audible indicator, and a tactile indicator. The indicators I associated with the power transfer device **70** may be located on or adjacent to the power transmitter **74**, on the floor surface F, on the wall surface W, on a user interface UI coupled to the power transfer controller **92**, or any other suitable location. The indicators I associated with the patient transport apparatus **30** may be located on or adjacent to the power receiver assembly **76**, the base **34**, the headboard **52** and/or footboard **54**, the side rails **44**, **46**, **48**, **50**, or any other suitable locations. The indicators I may comprise LEDs, displays, speakers, eccentric motors to generate tactile feedback, piezoelectric devices, and the like.

A state detector SD is coupled to the apparatus controller **90** to determine a state of the energy storage device B. The state of the energy storage device B may comprise an energy level of the energy storage device B, a current capacity of the energy storage device B, whether the energy storage device B is being actively charged, when the energy storage device B will be depleted, a time remaining for operation of the patient transport apparatus **30** based on the current state of the energy storage device B, and the like. The state detector SD may comprise any suitable electronic component or circuitry for measuring such states. For instance, the state detector SD may comprise one or more of a voltmeter, an amp-hour meter, and the like. Such states can also be indicated to the user via additional indicators I.

Referring to FIGS. **4** and **8**, the patient transport apparatus **30** may comprise a unique identifier that is used by the power transfer controller **92** to confirm that the patient transport apparatus **30** (or power receiver **78** thereof) is an approved device authorized to receive power from the power transfer device **70**. This can be used as an obstacle detection method to avoid charging foreign objects sensed on the mat/pad or objects not approved or designed for charging. Once the power transfer controller **92** determines that the unique identifier matches one or more approved identifiers, then the power transfer controller **92** allows power transfer to commence by activating the power transmitter **74** appropriately. If the identifier is not recognized by the power transfer controller **92**, the power transfer device **70** may be inoperable for power transfer. A reader R (e.g., RFID reader) may be coupled to the power transfer controller **92** to read the identifier of the patient transport apparatus **30**. The identifier may be embodied in an identification device, such as a tag T. Such tags T could comprise a radiofrequency identification tag (RFID), NFC tag, or other suitable tag. For example, the identifier could also be embodied in a bar code to be read by the reader R. Other forms of identification of the patient transport apparatus **30** are also contemplated. Additionally, or alternatively, the identifier may be stored in memory (e.g., NvRAM) of the apparatus controller **90** to be transmitted to the power transfer controller **92** via the communication devices C.

Referring to FIG. **9**A-9C, an alternative power transfer device **200** is shown in the form of a mat. This power transfer device **200** comprises a power transmitter assembly **202** with a power transmitter **204**. In this embodiment, the power transfer device **200** is similar to the power transfer device **70** except for size and arrangement. An alignment system **206** comprises a casing **208** supporting the power transmitter assembly **202**. The casing **208** comprises a geometric structure sized and shaped to guide the patient transport apparatus **30** so that a power receiver **78** of the patient transport apparatus **30** is aligned with the power transmitter **204** when the patient transport apparatus **30** is wheeled over the casing **208**.

Referring to FIG. **9**B, in this embodiment, the mat has a first width W**1** and the patient transport apparatus **30** has a second width W**2** between two of the wheels **58** (e.g., between head end wheels or between foot end wheels). The second width W**2** may be measured between centers of the wheel stems or some other suitable location. The second width W**2** is substantially the same as the first width W**1** so that the two of the wheels **58** straddle the mat when the patient transport apparatus **30** is moved over the mat to align the power receiver **78** and the power transmitter **204**. In other embodiments, the first width W**1** is at least 50, 60, 70, 80, or 90% of the second width W**2**. Additionally, in some cases, to further ensure alignment, the mat has a first length L**1** (see FIG. **9**C) and the patient transport apparatus **30** has a second length L**2** between two of the wheels **58** (e.g., between left side wheels or between right side wheels), wherein the first length L**1** is greater than the second length L**2** so that the patient transport apparatus **30** can be fully seated over the mat with all wheels **58** straddling the mat. The second length L**2** may be measured between centers of the wheel stems or some other suitable location. Owing to the relative sizes of the power transmitter **204** and the power receiver **78**, alignment of the power transmitter **204** and the power receiver **78** is ensured if all the wheels **58** straddle the mat.

Referring to FIG. **10**, another alignment system **300** is shown to align the power transmitter **74** and the power receiver **78**. In this embodiment, the alignment system **300** comprises markings **302** on the floor surface F to direct the user where to place the wheels **58** of the patient transport apparatus **30** when positioning the patient transport apparatus **30** over the power transmitter **74**. The markings **302** are sized and shaped to indicate recommended pathways for the wheels **58**. In the embodiment shown, the markings **302** comprise strips, such as stickers, paint, or the like, placed on the floor surface F. The markings **302** are also spaced from each other and parallel to each other so that if the user wheels the patient transport apparatus **30** over the power transmitter **74** while keeping the wheels **58** on the markings **302**, the power transmitter **74** will be sure to be at least laterally aligned with the power receiver **78**. Additionally, or alternatively, the alignment system **300** further comprises stops **304** located on the floor surface F at the ends of the markings **302** to be engaged by the wheels **58** to provide tactile indication to the user that the power transmitter **74** is longitudinally aligned with the power receiver **78**. The stops **304** act as a curb to prevent further motion of the patient transport apparatus **30** once engaged. The stops **304** may comprise blocks, metal brackets, or the like placed on the floor surface F and protruding above the floor surface F. The stops **304** may be fixed to the floor surface F. The stops **304** may also be fixed to the wall and may protrude from the wall surface W. The alignment system **300** shown in FIG. **10** could likewise be used to align the patient transport apparatus **30** with a power transfer device located on the wall surface W.

Referring to FIGS. **11-13**, an alternative power transfer device **400** is shown in the form of a mat. This power transfer device **400** comprises a power transmitter assembly **402** with a power transmitter **404**. In this embodiment, the power transfer device **400** is similar to the power transfer device **70** except for size and configuration. An alignment system **406** comprises a casing **408** supporting the power transmitter **404**. The casing **408** comprises a geometric structure sized and shaped to guide the patient transport apparatus **30** so that a power receiver **410** of the patient transport apparatus **30** is aligned with the power transmitter **404** when the patient transport apparatus **30** is wheeled over the casing **408**.

In this embodiment, the casing **408** has side portions on opposing sides of a floor engaging portion **413**. These side portions comprise raised wings **412** that define a channel **414** sized and shaped to receive one of the wheels **58** of the patient transport apparatus **30**. In this case, the power receiver **410** is part of a power receiver assembly **416** mounted to the base **34** adjacent to the wheel **58** so that if the wheel **58** is generally, centrally located on the floor engaging portion **413**, then the power receiver **410** is aligned with the power transmitter **404** in a way that enables power transfer to occur (see FIG. **12**).

Referring to FIG. **13**, the mat has a first width W**1** and the patient transport apparatus **30** has a second width W**2** between two of the wheels **58** (e.g., between the head end wheels or between the foot end wheels). The second width W**2** is larger than the first width W**1** so that only one of the wheels **58** can engage the mat at one time. The wings **412** may be raised a distance off the floor surface F that is less than a distance from the floor surface F to the base **34** so that the base **34** is able to move over the wings **412** without contacting the wings **412**, e.g., so the only part of the patient transport apparatus **30** able to engage the mat is one of the wheels **58**. In other embodiments, two mats may be provided, one for each of the front wheels **58**, wherein both wheels **58** must engage their respective mat to enable power transfer to occur. Sensors S coupled to one or both of the controllers **90**, **92** may be used to detect such contact and activate the power transmitters of the separate mats.

Referring to FIGS. **14A-14C**, an alternative power transfer device **500** is shown in the form of rigid casing **508** mounted to the floor. The casing **508** may be mounted to the floor by fasteners, adhesive, and the like to fix the casing **508** to the floor surface F or within the floor, e.g., beneath the floor surface F. This power transfer device **500** comprises a power transmitter assembly **502** with a power transmitter **504**. In this embodiment, the power transfer device **500** is similar to the power transfer device **70**. An alignment system **506** comprises the casing **508** supporting the power transmitter assembly **502** above the floor surface F. The casing **508** comprises a geometric structure sized and shaped to guide the patient transport apparatus **30** so that a power receiver **510** of the patient transport apparatus **30** is aligned with the power transmitter **504** when the patient transport apparatus **30** is wheeled over the casing **508**.

In this embodiment, the alignment system **506** further comprises a guide **512** sized and shaped to receive and mate with the casing **508** when the casing **508** is fully seated within the guide **512**. The guide **512** is part of a power receiver assembly **516** mounted to the base **34**. The guide **512** comprises guide arms **520** that define a width therebetween that narrows toward the power receiver **510**. The guide **512** also has an opening **522** with a width sized to receive the casing **508** when the guide **512** is moved into position over the casing **508** by the user. Owing to the rigidly fixed nature of the casing **508** to the floor surface F, if during initial engagement of the guide **512** with the casing **508**, the two are not aligned, i.e., the casing **508** instead engages one of the guide arms **520**, then that engagement acts to steer the patient transport apparatus **30** into proper alignment. For instance, referring to FIG. **14**B (compare to FIG. **14**A), when the casing **508** engages the guide arm **520**, the force involved with such contact, along with continued pushing of the patient transport apparatus **30** by the user in a generally longitudinal direction, will cause the wheels **58** to swivel to the orientation shown, so that the patient transport apparatus **30** is directed laterally until the casing **508** is rightly aligned with the guide **512** and able to fit into the opening **522** to align the power transmitter **504** with the power receiver **510**. FIG. **14**C illustrates the casing **508** seated in the opening so that the power transmitter **504** is aligned with the power receiver **510**.

Referring to FIG. **15**, multiple power transfer devices **70**, **400** may be employed to transfer power to multiple power receiver assemblies **78**, **416** either simultaneously or sequentially. The power transfer devices **70**, **400** may have differently sized/shaped/type or numbers of coils to transfer power, and similarly the power receiver assemblies **78**, **416** may have differently sized/shaped/type or numbers of coils to receive power. The power transfer devices **70**, **400** may be matched to the respective power receiver assemblies **78**, **416** in a way that quick, less efficient, power transfer occurs through one matched pair, while slower, more efficient, power transfer occurs through the other matched pair.

Referring to FIGS. **16-18**, the patient transport apparatus **30** is shown with an alternative power receiver assembly **600** with power receiver **602** mounted to the support frame **36** adjacent to the headboard **52**. In this embodiment, a power transfer device **604** has a power transmitter assembly **606** with a power transmitter **608** that is oversized as compared to the headboard **52** (see FIG. **17**) and the power receiver (see FIG. **18**) so that as the user is moving the patient transport apparatus **30** into position for power transfer, the user is able to easily visually reference the edges of the power transmitter **608** so that alignment with the power receiver **602** is easily accomplished. More specifically, the headboard **52** has a first width W**1** and the power transmitter **608** has a second width W**2** larger than the first width W**1**. Likewise, visible markings **609** on the wall surface W having a width larger than the headboard **52** could similarly provide a suitable alignment system—in this case the power transmitter **608** could be smaller than the headboard **52**. In other embodiments, the visible markings **609** could comprise an outline of the headboard **52** with a similar size and/or shape of the headboard **52** so that the user only need to match up the headboard **52** with its outline on the wall surface W to ensure alignment. In this case, one or more locators L could be used to assist with alignment, but may be unnecessary as the user is able to visually align the power transmitter **608** and the power receiver **602**.

Referring to FIGS. **19-21**, an alternative power transfer device **700** is shown that comprises two power transmitter assemblies **702**, each with its own power transmitter **704**. Similarly, the patient transport apparatus **30** comprises two power receiver assemblies **706**, each with its own power receiver **708** (only one shown). In this embodiment, each power transmitter **704** is sized and shaped to be contacted by one power receiver **708** to enable power transfer. One or more sensors S coupled to one or both of the controllers **90**, **92** could be provided in the power transmitter assemblies **702** and/or the power receiver assemblies **706** to verify such contact or to verify that the power transmitters **704** are in a desired proximity to their associated power receivers **708**. Such sensors S may comprise contact switches, hall-effect sensors, other proximity sensors, or the like.

If one of the power receivers **708** is overlying both of the power transmitters **704** (referred to as a short condition), then the power transmitters **704** would be disabled. In some cases, the power transmitters **704** and/or power receivers **708** are sized and shaped, and spaced from one another at such a distance that one power receiver **708** is unable to contact both power transmitters **704** simultaneously. Still, the power transfer device **700** is configured so that the sensors S must first transmit signals to the power transfer controller **92** indicating that the corresponding pairs of power transmitters **704** and power receivers **708** are in contact before activating power transfer through the power transmitters **704**. As shown in FIGS. **19** and **20**, a display **710** could be provided in a conspicuous location on the wall surface W, floor surface F, on the patient transport apparatus **30**, and/or on the power transfer device **700** that indicates when such contact has successfully been made and power transfer activated.

The arrangement of coils, windings, or other current carrying wires for the power transmitters and the power receivers described herein can comprise a number of different configurations. In the embodiment shown in FIGS. **22** and **23**, an array **750** of coil modules **752** are located on a substrate **754** to form the power transmitter or the power receiver. The array **750** of coil modules **752** can be arranged in a grid pattern as shown or other suitable pattern. Each of the coil modules **752** may comprise a single coil or winding, multiple coils or windings, and/or combinations thereof. The coils/windings may have a circular, spiral, or rectangular shape when viewed in plan, or any other suitable shape for enabling wireless power transfer from the power transmitter to the power receiver.

In some cases, the array **750** of coil modules comprises coil modules of a first type arranged in a central portion **756** of the array and coil modules of a second type arranged along an outer periphery **758** of the array **750**, e.g., the outer rows/columns of coil modules. The array **750** may comprises spaced apart coil modules **752** as shown, or may comprise overlapping coil modules. The coil modules **752** at the edges of the array **750** may be one type of coil that allows for incomplete alignment, but provides some charging, while the coil modules **752** in the central portion are better aligned and at a smaller distance from the power receiver to do the majority of the charging. For example, the coils in the wings **412** in the embodiment of FIGS. **11-13** could be different than the coils in the floor engaging portion **413**.

A combination of coils that charge according to different charging protocols may also be utilized, such as coils that charge according to the Qi wireless charging standard and coils that charge according to the A4WP wireless charging standard. In this case, if coil modules of different types are used, the coil modules are spaced at such a distance to avoid interference.

In some cases, the power transmitters described herein may be sized to be suitably aligned with more than one patient transport apparatus **30** at one time to charge more than one patient transport apparatus **30**. In this case, the power transmitter may have separately and selectively activatable coils or zones of coils to transfer power. The power transmitter may be configured to selectively transfer power to a first power receiver of a first patient transport apparatus **30** and a second power receiver of a second patient transport apparatus **30**. Operational parameters of one or more of the power transmitter and the power receivers may be controlled by one or more of the controllers **90**, **92** to coordinate power transfer from the power transmitter to each of the power receivers, e.g., simultaneously, sequentially, etc. For instance, one or more of the coils may be selectively energized to transfer power to one power receiver, but not another. Sensors S may be coupled to the apparatus controller **90** and/or the power transfer controller **92** to determine if the power receivers of the patient transport apparatuses **30** are aligned with the power transmitter to receive power. The power transfer controller **92** may be configured to adjust a transmission frequency of the power transmitter to transfer power sequentially to the multiple power receivers and/or to control the transmission frequency of the power transmitter to be on resonance or off resonance with respect to one or more of the power receivers.

In some embodiments, data communication between the power transfer device and one or more of the patient transport apparatuses **30** may be provided through a harmonic of the transmission frequency. Communication may occur between one or more of the following: the power transmitter and the power receiver; different power transmitters; and different power receivers. Communication can be used to verify the presence of the power receiver and that it is compatible with the power transmitter. Modulation of the voltage in the power transmitter, for instance, can also be used to send data to the apparatus controller **90** coupled to the power receiver. The power receiver can likewise communicate data back to the power transfer controller **92**. The data may comprise signal strength, control errors, end power commands, and the like. Signal strength can help align the power transmitter and the power receiver by directing the user to move the power receiver as needed to improve the signal strength. Control error may indicate the amount of error between input voltage seen by the power receiver and the voltage required. The power transfer controller **92** may adjust the voltage based on this feedback in a control loop. Thus, power delivery can be tuned based on this feedback.

Referring to FIG. **24**, an elongated power transfer device **800** (also referred to as a charging lane) may be provided on the floor surface F (or alternatively on the wall surface W, as shown in hidden lines). The elongated power transfer device **800** comprises either a single continuous power transmitter assembly **802** with a single power transmitter **804** or multiple power transmitter assemblies with multiple power transmitters **804** arranged serially along the floor surface F (or wall surface W). In either case, one or more lane markings **806** (stickers, paint, etc.) delineated on the floor surface F may indicate where the user is to push the patient transport apparatus **30** by indicating, for instance, pathways for the wheels **58** to follow or a centerline along which the patient transport apparatus **30** should be pushed. Separate indicators I could also be attached to the floor surface F adjacent to the lane markings **806** to indicate if power is being transferred, such as LEDs in the floor surface F placed along the lane markings **806**. Other locations for the indicators I are also contemplated (e.g., as part of the patient transport apparatus **30**, etc.). If the wheels **58** are kept on the wheel pathways or a center of the patient transport apparatus **30** is kept on the centerline, then the power transmitters **804** are able to transfer power to the power receiver **78** on the patient transport apparatus **30**. Thus, the markings **806** guide the user to move the patient transport apparatus **30** to the charging area to initiate the transfer of power from the power transmitter **804** to the power receiver **78**.

In some cases, sensors S coupled to the power transfer controller **92** are also continuously placed alongside the power transmitter **804** to detect where, along the path, the power receiver **78** is located. As the patient transport apparatus **30** is wheeled along the passageway, portions of the power transmitter **804** (or separate power transmitters **804**) that are in a desired proximity of the power receiver **78** (e.g., those for which the power receiver **78** is directly overhead) are selectively activated so that power transfer remains localized to the area of the power transfer device **800** in alignment with the power receiver **78**. This helps to avoid energizing the power transmitter(s) **804** in locations where the user steps or where other objects may rest. Such locations are also too remote from the power receiver **78** to enable suitable power transfer.

As shown, in FIG. **25**, multiple power transfer devices **900**, each having a power transmitter assembly **902** with a power transmitter **904**, are provided to transfer power to multiple patient transport apparatuses **30** simultaneously or sequentially. The power transmitters **904** may be placed along the floor surface F or the wall surface W to define a charging location with multiple charging areas. The multiple power transmitters **904** may be located throughout a facility to make connecting the patient transport apparatus **30** to a power source more convenient for users. As shown in FIG. **25**, the exemplary power transfer device **900** (could be the same as power transfer device **70**) is shown mounted to the floor surface F. Floor markings **906** provide an alignment system to align the patient transport apparatuses **30** with one of the power transmitters **904**. The power transmitters **904** may be unpowered until a connection with a power receiver **78** is detected, e.g., as detected by one or more sensors S such as hall-effect sensors, cameras, proximity sensors, or the like. Power may be transferred through inductive coupling as previously described.

Referring to FIG. **26**, in one embodiment, a single power transfer device **70** can be used to transfer power to multiple patient transport apparatuses **30** in a daisy-chained manner. In particular, the power transmitter **74** transfers power to a power receiver **78** in the same manner previously described. A second patient transport apparatus **30** is then charged via a charging conduit **1000** interconnecting a second energy storage device B on the second patient transport apparatus **30** to the power receiver **78**. Current from the power receiver **78** could be automatically routed to the second energy storage device B once the first energy storage device B on the first patient transport apparatus **30** is full of charge, or a manual switch SW could be activated to transfer charging to the second energy storage device B. Additional patient transport apparatuses **30** could be charged in this manner as shown. Similarly, the coils/windings in the power receiver **78** could initially be configured to generate current in response to the magnetic field created by the power transmitter **74** to receive energy from the power transmitter **74**, but the coils/windings in the power receiver **78** could subsequently be configured to act as a power transmitter by the apparatus controller **90** in order to transfer power to the power receiver **78** on the second patient transport apparatus **30**.

Referring to FIGS. **27** and **28**, an alternative type of power transfer device **1100** is shown comprising a power transmitter assembly **1102** having a power transmitter **1104**. The power transmitter **1104** in this embodiment comprises a light energy emitter panel mounted to the floor, wall, or ceiling. The light energy emitter panel may comprise LEDs or other light emitters mounted thereto that are connected to the fixed power source FPS (or other power source) and a controller (such as power transfer controller **92**) to be controlled in a suitable manner to transmit light energy. A power receiving assembly **1106** has a power receiver **1108** mounted to the base **34**. The power receiver **1108** comprises a photovoltaic receiver panel connected to the powered devices PD and the energy storage device B of the patient transport apparatus **30** in the same manner as the power receivers previously described. The light energy emitter panel can be aligned with the photovoltaic receiver panel in any of the ways previously described herein for aligning power transmitters with power receivers. Moreover, any of the power transmitters and power receivers previously described could instead, or additionally, employ this light energy based arrangement for wirelessly transferring power from the fixed power source FPS to a patient transport apparatus **30**.

Photovoltaic cells are one way to transfer energy without using a wired connection to the facility. In this embodiment, the amplitude and frequency of the energy source (e.g., the LEDs) can be tuned with the photovoltaic receiver panel to ensure that energy transfer occurs at a desired rate, such as a maximum rate. Additionally, light from the light energy emitter panel could be in the non-visible spectrum. Additional energy harvesting methods could be used in addition to harvesting light energy. Vibration energy, motion energy, heat energy, and other forms of energy could be captured to complement the other forms described herein and could be similarly directed to the energy storage device B. For instance, motion of the patient transport apparatus **30** could operate a generator (not shown) coupled to one of the wheels **58** to generate energy as the wheel **58** rotates when the user moves the patient transport apparatus **30**. The generator feeds energy directly to the energy storage device B.

Referring to FIG. **29**, another power transfer device **1200** is shown comprising a power transmitter assembly **1202** having a power transmitter **1204** in the form of an energy surface **1207** that is configured to deliver natural light to a power receiver assembly **1206** having a power receiver **1208** mounted to the support frame **36**. The power receiver **1208** comprises a photovoltaic receiver panel (e.g., solar panel) coupled to the energy storage device B. The energy surface **1207** is configured to deliver natural light, e.g., sunlight, to the photovoltaic receiver panel. Referring to FIG. **30**, one or more light directing elements **1210** are arranged to redirect the natural light toward the energy surface **1207** so that the natural light is received by the photovoltaic receiver when the photovoltaic receiver is in a desired proximity to the energy surface **1207**. Any of the locators L or other alignment systems previously discussed could be used to provide alignment between the energy surface and the photovoltaic receiver.

As shown in FIG. **30**, natural light NL could enter the facility through a skylight, opening in the roof, window, or the like, and be redirected toward the energy surface by one or more of the light directing elements **1210**. The light directing elements **1210** may comprise one or more mirrors, lenses, prisms, and the like. The light may be directed to pass generally perpendicularly through the energy surface **1207** to be routed directly to the photovoltaic receiver. The energy surface **1207** may be transparent or at least translucent (e.g., surface of transparent/translucent panel) to allow light to pass through. Alternatively, the energy surface **1207** may form part of a light emitter panel that has photovoltaic cells to convert the natural light NL into light energy, light emitting elements (e.g., LEDs) to emit artificial light from the energy surface **1207**, and a controller to control energy storage and transmission. In some embodiments, one or more openings may be present in the energy surface, wherein the natural light is directed through the one or more openings to reach the photovoltaic receiver.

It will be further appreciated that the terms "include," "includes," and "including" have the same meaning as the terms "comprise," "comprises," and "comprising."

Several embodiments have been discussed in the foregoing description. However, the embodiments discussed herein are not intended to be exhaustive or limit the invention to any particular form. The terminology which has been used is intended to be in the nature of words of description rather than of limitation. Many modifications and variations are possible in light of the above teachings and the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A power transfer system comprising:

a patient transport apparatus comprising:

a support structure having a base and a patient support surface for a patient;

an energy storage device;

a power receiver coupled to said energy storage device; and

wheels coupled to said support structure to facilitate transport of said patient transport apparatus over a floor surface and relative to a wall surface;

a power transfer device comprising a controller and a power transmitter coupled to said controller and configured to deliver power from a power source to said power receiver;

an alignment system arranged to align said power transmitter and said power receiver when a user moves said patient transport apparatus over the floor surface on said wheels and relative to the wall surface so that said power transmitter is capable of transferring power to said power receiver, wherein said power transmitter is configured to remain fixed from movement during such alignment; and

a sensor coupled to said controller to determine if said power receiver is aligned with said power transmitter to receive power;

wherein said power transmitter is configured to contact said power receiver when said power transmitter is aligned with said power receiver and ready to transfer power, said controller being configured to determine that said contact occurred before allowing the transfer of power; and

wherein said controller is configured to determine a proximity of said power transmitter to said power receiver and allow the transfer of power upon determining that said power transmitter is in a desired proximity.

2. The power transfer system of claim **1**, wherein said power transmitter comprises one or more of: a pad configured to be arranged on the wall surface; and a mat configured to be arranged on the floor surface.

3. The power transfer system of claim **2**, wherein said power transmitter comprises said mat and said mat has a first width and said patient transport apparatus has a second width between two of said wheels, said second width being substantially the same as said first width so that said two of said wheels straddle said mat when said patient transport apparatus is moved over said mat to align said power receiver and said power transmitter.

4. The power transfer system of claim **2**, wherein said power transmitter comprises said mat and said mat has a first width and said patient transport apparatus has a second width between two of said wheels, said first width being at least 50% of said second width.

5. The power transfer system of claim **1**, wherein said power transmitter comprises one or more of:

a coil having a rectangular shape;

coils arranged in an array, wherein said array comprises a central portion and an outer periphery spaced outwardly therefrom, said coils arranged in said array comprising a first coil type arranged along said outer periphery and a second coil type arranged in said central portion, wherein said power receiver is configured to receive power from one of said coils arranged in said array and said patient transport apparatus comprises a second power receiver to receive power from another of said coils arranged in said array; and

first and second coils, wherein said controller is configured to transfer power from said first coil to said power receiver according to a first protocol and to transfer power from said second coil to said power receiver according to a second protocol, different than said first protocol, said first and second coils being spaced apart.

6. The power transfer system of claim **1**, comprising an obstacle detection system configured to determine if any obstacles will interfere with the transfer of power from said power transmitter to said power receiver and an identification device configured to transmit a unique identifier to said controller to authorize the transfer of power from said power transmitter to said power receiver, wherein said controller is configured to determine said unique identifier to authorize said power receiver before commencing transfer of power from said power transmitter to said power receiver.

7. The power transfer system of claim **1**, wherein said alignment system comprises a display to display the current alignment relative to a desired alignment, wherein said alignment system comprises markers associated with one of said power transmitter and said power receiver, said sensor configured to detect said markers to determine the current alignment of said power transmitter and said power receiver.

8. The power transfer system of claim **1**, wherein said alignment system comprises markings on one or more of the floor surface and the wall surface to assist the user with aligning said power receiver with said power transmitter.

9. The power transfer system of claim **1**, wherein said power transmitter comprises a mat having a floor engaging portion and side portions to define a channel, said floor engaging portion comprising a first transmitter coil and said side portions comprising second and third transmitter coils, wherein said power receiver comprises a receiver coil located to pass into said channel to align with said transmitter coils when moving said patient transport apparatus.

10. The power transfer system of claim **1**, wherein said alignment system comprises a charging lane delineated on the floor surface to guide the user to move said patient transport apparatus to said charging lane to initiate the transfer of power from said power transmitter to said power receiver, wherein said power transfer device comprises a plurality of said power transmitters placed along the floor surface in said charging lane, wherein said controller is configured to detect said patient transport apparatus being located in said charging lane to activate said power transmitter to transfer power to said patient transport apparatus.

11. The power transfer system of claim **1**, wherein said sensor is configured to determine if power is being transferred from said power transmitter to said power receiver, said controller being configured to determine a quality parameter of power transfer associated with alignment of said power transmitter and said power receiver; and

an indicator coupled to said controller and arranged to indicate that power is being transferred from said power transmitter to said power receiver and to indicate said quality parameter, wherein said indicator comprises one or more of a visual indicator, an audible indicator, and a tactile indicator.

12. The power transfer system of claim **1**, wherein said sensor is configured to detect a second power receiver located to receive power from said power transmitter, and wherein said controller is configured to adjust a transmission frequency of said power transmitter to transfer power sequentially to said power receivers.

13. The power transfer system of claim **1**, wherein said power receiver is selectively operable as a second power transmitter configured to transfer received power to a second power receiver of a second patient transport apparatus so that power is transferred to said power receivers in a daisy-chained manner.

14. The power transfer system of claim **1**, wherein said sensor is configured to sense charging activity of said power receiver during power transfer and wherein said controller is configured to analyze signals from said sensor and to modify operational parameters of said power transmitter to account for sensed charging activity of said power receiver.

15. The power transfer system of claim **1**, wherein power transfer is configured to occur according to a power transfer frequency and further providing data communication through a harmonic of the power transfer frequency between one or more of the following:

said power transmitter and said power receiver;

said power transmitter and a second power transmitter; and

said power receiver and a second power receiver.

16. The power transfer system of claim **1**, wherein said power transmitter comprises an energy emitter and said power receiver comprises a photovoltaic receiver, wherein said controller is configured to tune an amplitude and frequency of said energy emitter with said photovoltaic receiver so that energy transfer occurs at a desired rate.

17. The power transfer system of claim **1**, comprising a second energy source resulting from one of vibration, motion, and heat of the patient transport apparatus, wherein said second energy source and said power receiver direct energy into said energy storage device.

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